

The quest for new physics. An experimentalist approach.

Vol.3 The new cosmology.

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Abstract.

In this book the ideas expressed in Vol.1 [1] and Vol.2 [2] will be applied to answer the questions of cosmology in general. If author rejects Big Bang, how it is possible to reconcile all the observations with the new paradigm? And what would be instead of dark matter and dark energy? How the Universe may live in the quasi-stationary state with stars still shining? And what would be the approximate age of it on the lower end? The answers are in the book. Contrary to Vol.1, which is less speculative (merely an array of the proposals for future experiments) and Vol.2, which is mainly a critique of the present day paradigm, Vol.3 will be highly speculative. Indeed, despite some of the ideas outlined in Vol.1, Vol.2 got confirmation from James Webb Space Telescope, the approximate outline of new cosmology has a lot of bifurcation points: two or more speculative paths of explanation seems equally reasonable and rational. Only future experiments may help to create the full picture of the Universe (and this is return to the main idea of Vol.1).

References to Abstract.

[1] Dmitriy S. Tipikin “The quest for new physics. An experimentalist approach. Where to find new physics?”// LAP Lambert Academic Publishing, 2021.

[2011.0172v1.pdf](#) (vixra.org) or
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[2] Dmitriy S. Tipikin “The quest for new physics. An experimentalist approach. Vol.2 Reflections on tired light hypothesis versus Big Bang” // LAP Lambert Academic Publishing, 2022.

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Chapter 1. Introduction.

Since the first [1] and second [2] books were written, the James Webb Space Telescope continues to deliver more and more data completely orthogonal to the paradigm of Big Bang. While initial observations were only about the too many galaxies at high Z shift, recent observations generated even more puzzling results. The idea to directly measure the content of oxygen and carbon in the galaxy at $z=12.5$ (in Big Bang chronology only 350 millions of years old) revealed the spectrum which must be generated by stars older than the Sun [3]. Because the galaxy is so far and so feeble, James Webb Space Telescope spent several days accumulating data just to confirm: something is very wrong with Big Bang paradigm. Instead of spectacular confirmation of extra-low metallicity of stars at high z quite the opposite is found – galaxy is very old, well structured, very similar to ones observed in near space (small $z < 2$). The proponents of Big Bang were very happy to present the so-called “green pea” galaxies [4] at $z=8$, similar to young unstructured “green pea” galaxy found at lower z . Indeed, such galaxies should be abundant at high z (if Big Bang cosmology is assumed) and much less popular at low z . But soon the discovery of extremely red galaxies (very old and generating virtually no stars, supposedly galaxies “from the future”, dead galaxies) also at high z was announced [5,6].

Again and again the predictions of Big Bang paradigm failed to deliver something clearly demonstrating the trend in galaxies properties: from young at high z to old at low z ; from very low metallicity at high z to Sun-like metallicity at low z ; from unstructured “blobby” galaxies to galaxies with bar like Milky Way clearly visible at low z (on the opposite, many “young” galaxies at high Z have very pronounced bar, previously expected to be possible after few billions of years of age [7]). Instead it is more and more obvious that the galaxies at high Z are identical to galaxies at low Z (a match may be always found both for high and low z), except of the red-shift of spectrum, of course. And those facts are in addition to well established fact of absence of Tolman effect (absence of Tolman effect was discovered already by Hubble Space Telescope [8]). Taken together those facts are more and more obsoleting Big Bang paradigm and shifting attention to other theories, like tired light (there are actually many variants of this concept, developed well behind the original concept of Compton scattering). The recent article about tired light and how it fits the galaxies sizes is here [9].

But rebuttal of Big Bang means a revolution in cosmology, since it is based on consideration of red shift as Doppler-like phenomenon, not upon idea of photons slowly losing energy during propagation. Those concepts are inconsistent with each other (it is not like Newton physics became a special case of more general Einstein physics or Schrodinger physics). If light is slowly losing energy at propagation, the concept of Big Bang will become obsolete similar to Earth-centered cosmology become obsoleted in enlightenment epoch. And origin of Universe would be completely unknown.

Actually well before appearance of Big Bang paradigm the Universe was considered as infinite and eternal. And there were rejections from several authors [10]. The most important rejection would be Olbers’s paradox – because of the infinite Universe the sky should be bright, not dark [11]. Another rejection was with stars itself – since they are using limited resources, they should not exist in eternal Universe – all the energy should be already converted to light (and high energy particle which we know about now) and only dead stars (black holes and neutrons stars as we know by now) in addition to energy would be present – the heat death paradox [12]. Those two paradoxes (Olbers’s paradox and heat death) are old paradoxes, formulated before Einstein and Schrodinger.

In addition to old paradoxes modern physics added new ones: how to explain microwave radiation in static universe, what is dark matter and dark energy. Undoubtedly there are many more paradoxes to resolve and phenomena to explain, but usually it is stated that those are contradict to any paradigm except for Big Bang. In the present book the new cosmology will be outlined how it is solving old and new paradoxes will be described. However, even with most recent discoveries made by James Webb Space Telescope there are several alternative ways in addition to Big Bang. It is necessary to note, that Big Bang has some big unresolved problems too. One of them is the asymmetry of matter and antimatter – according to Big Bang paradigm they should be equal and the reason the asymmetry is present is unexplained. For the case of Static Universe (red shift is explained by tired light) this problem is not solved, of course, it is merely postponed – the origin of Universe is not even speculated at all, the explanation of the closer unexplained phenomena (accelerated rotation of galaxies, reddening of light, “dark energy”) are to be solved first.

In order to clarify possible solutions of the paradoxes it is necessary to use experimentalist approach and first consider what observation is most crucial for Big Bang paradigm. This is of course red shift. There are three main areas of explanation of this phenomenon:

1.This is Doppler-like phenomenon due to something moving. Since the red shift is isotropic it leads of the idea of expanding Universe and eventually to Big Bang paradigm. The strongest argument for Big Bang is actually not red shift itself but the dispersion of it. It depends upon the energy in following way – change in energy (with distance, time) is proportional to the energy itself: for photon $\Delta f = -\text{Const} \cdot f$, where Δf is the change of frequency, f – frequency itself. This ratio is already verified using James Web Space Telescope for ~2-3 orders of magnitude for frequencies f (the spectra are shifted according to this ratio for $z \sim 14$, which is 15 times change in energy plus each spectrum is spanned at least 1 order of magnitude if measured from ultraviolet in infra-red in rest frame). As it will be shown later, such dependence is impossible to explain by any mechanism in quantum mechanics (possible in classical physics, by the way) for the slow energy drain of photon.

2.Tired light hypothesis (actually this is the generic name for numerous ideas starting from Zwicky [13]) – photons are slowly losing energy due to some undiscovered yet phenomenon. While postulating that energy loss should be proportional to energy seems obvious, no quantum mechanics phenomenon may create such a drain, and photons, being quanta, are supposed to obey quantum mechanics. That makes the use of tired light hypothesis difficult.

3.Space-time itself has some undiscovered yet properties, possible even in the static Universe, which create effective reddening of light. In this case Einstein’s equations are considered as incomplete, some small member (members) to be added, which would not change perceptibly the existing proofs of General Relativity, but explained red shift in the case of static Universe [14]. This approach also have problems: modification of the metric will change the known solutions of Einstein’s equation leading to wrong existing and experimentally confirmed predictions.

Since the third approach needs good command of the theoretical physics, in the experimentalist approach I will concentrate mainly on second one (tired light), mentioning the third one if necessary.

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Chapter 2. Tired light theory revisited and modified.

a) Why classical tired light hypothesis from Zwicky failed?

According to Copenhagen interpretation of quantum mechanics and further development of quantum field theory photon is not real particle in the sense it only behaves like particle at the moment of absorption (when wavefunction collapses). It means that the light emitted by the galaxy 13 billion years ago experience absolutely no influence from the environment till the moment of detection by James Webb Space Telescope. It is reddening because of the space properties itself – seemingly the object is receding at high velocity (Doppler-like effect). In that sense the photon just before detection has a “length” of 13 billions light years and still “feels” the emitting atom of a star (because the wave function is not yet collapsed and photon may “miss” James Webb Space Telescope mirror and continue to travel). The same idea arises from quantum field theory – photon is a boson particle and merely an intermediary at carrying electromagnetic force. While this idea was reasonable at Einstein’s time, more forces were discovered since (strong and weak) with corresponding particles which not only participate at carrying force but also participate in other interactions (for example Z-boson for weak interaction has a finite mass). It means that there is a possibility that photon is not only responsible for electromagnetic interactions, but also participates in other interactions as well, some of them not yet discovered. Similar to Z-boson, which is responsible for weak interaction, but due to finite mass must participate in gravitational (or space-time distortions according to Einstein). The influence of the gravity inside the nucleus is enormously small but finite. In the same way photon is not something stretching huge distance before being absorbed, but rather a particle with finite size, participating in other interactions, despite in a very small part.

Here is a general idea why the physics deviates from the mathematics – physics does not have absoluteness and infinities. The idea that “physics is not mathematics” is not new [1] and may be demonstrated in multiple ways. Famous expression $-1 = \exp(-i\pi)$ would be mathematics (actually $-1 \equiv \exp(-i\pi)$ to emphasize absoluteness), but $-1 = \exp(-i\pi) + \text{other very small members}$ or even $-1 \sim \exp(-i\pi)$ in physics. In a sense any mathematical expression of idea in physics is just a fit, not an absolute, sooner or later to be replaced by better fit (not necessarily expressed using the same mathematical language). In that sense the idea of photon **absolutely not** interacting with something like quantum vacuum or fifth force or even simple dark matter in the sense of undiscovered yet particles is wrong. Maxwell equations are enormously good fit, but just a fit, something very small should be added to them in the future for even better description of the photon and electromagnetic waves. For now it is possible to assume that photon is both wave (almost completely) and particle (just a little bit) not only in absorption (collapse of wave function) but during all the existence of it in all coordinate systems (and not only in a coordinate system moving together with photon, where time is irrelevant). And thus photon somehow interacts with quantum vacuum or undiscovered yet particles on a route and may be slowly losing energy (not as a wave described by Maxwell equations of modern field theory) but as something else (particle, axion-like, 5th force boson, or something we can not even imagine yet).

In that sense the idea of confrontation between tired light theory (photons are losing energy enroute due to some new mechanism) and Doppler-like explanation (Big Bang happened and Universe is expanding) of the red shift is the war between locality principle (photon is local, it forgot

wavefunction of the atom which emitted it after the coherence length of photon is traveled $\sim 3m$ for the typical lifetime of excited state of the atom around $10\exp(-8)$ second and all its way to Earth is actually something self-contained and self-governed) and non-locality idea (which assumes that it is absolutely not interacting and essentially having a coherence length in some sense as big as 13 billions of light years). The same war of principles of locality and non-locality should be applied to accelerated rotation of galaxy – it is determined completely by galaxy itself (something inside the galaxy) plus local environment (possibly in clusters), the origin of galaxy is completely forgotten long ago – locality idea; not by the dark matter proportion which happened to be for this particular galaxy because of fluctuation during the Big Bang (non-locality idea, the dark matter in this particular galaxy is connected due to origin to the whole Universe through the event of Big Bang). Principle of locality applied to the whole Universe means that while some local non-equilibrium is possible (cluster of galaxies slowly developing or dismantling) almost everything in Universe is in near equilibrium or quasi-equilibrium already with any influence of previous events quickly forgotten.

The initial attempts to explain reddening of the light from far-far away were based mainly on the existing phenomena of light scattering, mainly Compton scattering, through one-time event. They all predicted strong blurring of the galaxies and thus were rejected [2]. In the situation of one-time event of scattering photon is scattered onto something much heavier than photon itself (in generalization of energy, of course, $m=hv/c^2$). In this situation the photon is still abiding well known ratio $E=p*c$. The scattering may take place in any direction, not necessarily along the propagation direction. Obviously the light scattering due to Compton effect in the perpendicular direction instantly creates the big change in the direction of light pulse and with such dominating process we would never see the far galaxies. Since the scattering is generated by known matter (dust, molecules which are much heavier than photon), the scattering takes place in one step. Due to relation $E=p*c$ the change in energy necessary to recreate the observed red shift means the huge change in pulse (if the red shift is assumed to happen in one step, if not – in multiple steps- the situation is dramatically different, see below). For example the red shift for the galaxy 80 millions of light years away is 0.005 of the initial value (measured for green light). The change of pulse would be also $0.005*p_0$ ($\Delta p/p_0=\Delta E/E_0$, directly from $E=p*c$ formula, here p_0 is the initial pulse and E_0 is the initial energy). Some of the scattering takes place perpendicular to the initial pulse (initial direction of photon propagation) and despite majority of the scattering is having smaller angles or even in the direction of propagation, the angle of scattering (what would lead to blurring of the image) is $\Delta p/p_0=0.005$ radian. The resolution (size) of such a galaxy in the good telescope would be also 0.005 radian. But, for example, for the detection of small dwarf galaxy IC4653 with visible size of 1.6 arcmin (0.000465 rad) at the distance of 80 millions of light years [3] the resolution necessary should be also 0.000465 rad, which is order of magnitude below the value of 0.005. Yet the galaxy is easily observed by Hubble Space Telescope and may be visualized in greatest details [4]. Corresponding pictures taken from Internet are published in my article on Vixra [5]. Such a strong contradiction was the main reason why the initial idea of the light reddening caused by scattering was rejected 100 years ago.

Contrary to any known mechanism of light scattering the well known Doppler-like mechanism relies on geometry of space-time (matrix of space time is expanding), has no scattering issues and eventually predominated.

There are other mechanisms of light scattering, for example Raman scattering, and in this mechanism the quantum loses only a small fraction of the energy. But despite the energy change in

each scattering act is small, the scattering may be repeated many times (to accumulate the necessary for the observed red shift energy change). Raman scattering energy shift may be smaller than 100 cm^{-1} and that corresponds to energy change of 0.012 eV. It means that for the same shift of 0.005 of initial energy for the galaxy for the green light photon (520 nm, 2.38 eV) exactly one scattering event is necessary ($0.012/2.38=0.00504$). Again the image would be blurred completely. If the much higher red shift is considered (say 100 acts of Raman scatterings, which corresponds to energy loss of 1.2 eV, and if the scattering takes place isotropically, it would mean that the scattering would be only $1/\sqrt{N}=1/10=0.1$ compare to expected for the energy change of 1.2 eV. This is because the statistical laws reign supreme and photons may be scattered back thus making total scattering much smaller compare to the one-act scattering (see detailed explanation below). While this is still very big scattering and Raman or Raman-like scattering instead of Compton-like scattering still can not pretend to be the source of reddening, the overall direction of scientific reasoning may finally help tired light idea. As it will be shown later, if the scattering is enormously small so that for light scattering corresponding to $Z=1$ trillions of events is necessary, the images of close (up to $Z=2$) galaxies will be still absolutely clear (resolution of telescope is finite, too), while for galaxies far away the blurring due to scattering may be actually observed (finally). This is because of the laws of statistics if energy drain is proportional to N (number of scatterings) the angle of scattering would be only proportional to \sqrt{N} (square root of N) because of isotropic scattering. The presence of such incredibly weak per event scattering makes the only way the tired light hypothesis may be valid. The unknown yet mechanism of light scattering – the scattering in each step is so enormously small, that despite the light is reddening (energy is lost) the direction of propagation does not change perceptibly (here is the statistical \sqrt{N} law should be very helpful). This idea was initially applied to the possible energy loss for the photons as having non-zero quantized gravitational dipole but that mechanism would create any perceptible blurring only at 10 orders of magnitude better resolution telescope than James Webb Space Telescope. All of a sudden the effect is already clearly visible on standard objects like supernovae at Z higher than 2 or 3 [7], what makes the strongest hint toward new physics present in observations.

B) Theoretical interpretation of tired light idea based on statistical approach.

In this approximation photon is losing energy in an enormously small steps (so only after billions of events the perceptible drain of energy is visible). The formula $E=p \cdot c$ universal for any photon – is assumed to work. There is an important assumption (and as it will be shown later, a difficult one, no easy to justify using quantum mechanics) – the energy loss in each step is proportional to the energy of the photon just before this step (this is necessary assumption because it will give the same dispersion as it should be for Doppler effect – energy red shift is directly proportional to the frequency, to the energy of the photon because of $E=h \cdot \nu$). Let E_0 be the initial energy of the photon [5]:

$$1. \Delta E_1 = \alpha E_0$$

$$2. \Delta E_2 = \alpha(E_0 - \Delta E_1) = \alpha E_0 - \alpha \Delta E_1 = \alpha E_0 - \alpha^2 E_0 = \alpha E_0(1 - \alpha)$$

$$3. \Delta E_3 = \alpha(E_0 - \Delta E_2 - \Delta E_1) = \alpha(E_0 - \alpha E_0 + \alpha^2 E_0 - \alpha E_0) = \alpha E_0 - 2\alpha^2 E_0 + \alpha^3 E_0 = \alpha E_0(1 - 2\alpha + \alpha^2) = \alpha E_0(1 - \alpha)^2$$

$$4. \Delta E_4 = \alpha(E_0 - \Delta E_3 - \Delta E_2 - \Delta E_1) = \alpha(E_0 - \alpha E_0 + 2\alpha^2 E_0 - \alpha^3 E_0 - \alpha E_0 + \alpha^2 E_0 - \alpha E_0) = \alpha E_0(1 - 3\alpha + 3\alpha^2 - \alpha^3) = \alpha E_0(1 - \alpha)^3$$

....

$$N. \Delta E_N = \alpha E_0(1 - \alpha)^N$$

For simplicity $1 - \alpha = \beta$, and $\alpha = 1 - \beta$, α is extremely small and β is very close to 1.

Then the total loss of energy by the photon after N scatterings is:

$$\Delta E = \sum_{i=1}^N (\alpha E_0 \beta^N) = \alpha E_0 \sum (\beta^N)$$

The sum is the **finite sum** (no simplification to the infinite sum is possible). This **finite sum** $\sum (\beta^N)$ is the sum of the **finite** geometric series [8] and the equation becomes:

$$\Delta E = \alpha E_0(1 - \beta^N) / (1 - \beta) = \alpha E_0(1 - \beta^N) / \alpha = E_0(1 - \beta^N) = E_0(1 - (1 - \alpha)^N)$$

For the change of pulse (vector quantity) in each step the formula would look like this:

$$\Delta p_i = \Delta p_i(\text{angle}_i)$$

Here Δp_i is the absolute value of the change of pulse (at scattering number i) and angle_i is an angle between the chosen direction (initial direction of light propagation) and the change of pulse (at scattering i). It is necessary to switch coordinate system to one which is moving with speed of light c in the direction directly between the light source and Earth. In this coordinate system the photon will be “wandering” stochastically in all directions similar to diffusion or Brownian motion. Since the scatterings are assumed to be stochastic (the assumption of the isotropy in the direction perpendicular to the direction of the light propagation is enough), the classical approach at the statistical analysis of polymer elongation is applicable here (ideal chain formula [9]):

$$(\sum \Delta p_i)^2 = \sum (\Delta p_i)^2 + \sum_i \sum_j \text{Cos}[\text{Angle}(i) \text{angle}(j)] (\Delta p_i)(\Delta p_j)$$

And since the angles are all stochastic, all the members with Cos are summed to zero (exactly like in [9]).

Therefore, the absolute value of a change in pulse after N scatterings is (formula $p=E/c$ is used here):

$$\Delta p_N = \Delta E_N / c = \alpha E_0 (1-\alpha)^N / c = \alpha p_0 \beta^N$$

$$(\Delta p)^2 = \sum (\alpha p_0 \beta^N)^2 = \alpha^2 p_0^2 \sum (\beta^2)^N = \alpha^2 p_0^2 (1 - (\beta^2)^{N+1}) / (1 - \beta^2) = \alpha^2 p_0^2 (1 - (1-\alpha)^{2N+2}) / ((1-\beta) * (1+\beta))$$

Since $1-\beta=\alpha$:

$$(\Delta p)^2 = \alpha^2 p_0^2 (1 - (1-\alpha)^{2N+2}) / (\alpha(2-\alpha)) = \alpha p_0^2 (1 - (1-\alpha)^{2N+2}) / (2-\alpha)$$

$$\Delta p = p_0 \sqrt{\alpha} \sqrt{(1 - (1-\alpha)^{2N+2}) / (2-\alpha)}$$

This formula is for change of pulse after N scattering only. In [5] it was incorrectly applied to the total angle of deviation for high Z (wrong approach because at each step the pulse also drops so the division of Δp by p_0 will not generate the angle of scattering). More correct approach is to consider the angle of scattering as a vector (obviously it may go into any direction if isotropic scattering is assumed) and average the vectors of scattering angles, not pulses. In this case the absolute value of angle of scattering is the same because of formula $E=p*c$. Namely: $\Delta E/E = (\Delta p*c)/(p*c) = \Delta p/p$

$\Delta p/p = \Delta E/E = \alpha$ (the key assumption used in the very beginning).

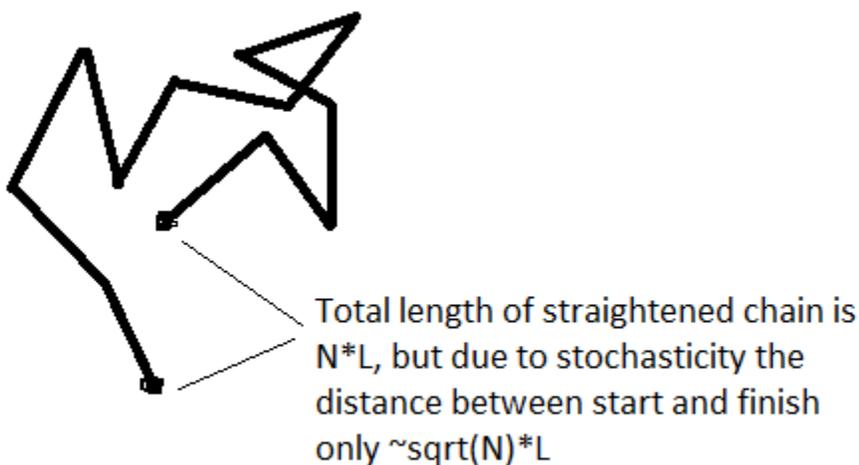
It means that the constant vector of scattering $\underline{\alpha}$ makes N isotropic movements (ideal chain in the purest form, or, of course, it is possible to use Einstein deviation of diffusion formula, the results should be the same – the total displacement will be proportional to \sqrt{N}).

$\underline{\Delta p}_i / p_i = \underline{\alpha}_i$ (here α is a vector with the same length but arbitrary direction).

$$\text{Angle} = \sum_{i=1}^N (\alpha_i); (\text{Angle})^2 = [\sum_{i=1}^N (\alpha_i)]^2 = \sum (\alpha)^2 + \sum_i \sum_j \text{Cos}[\text{Angle}(i)\text{angle}(j)](\alpha)(\alpha)$$

Because all vectors α_i are of the same length only different in directions.

Since all the angles are equally possible and number N is huge (trillions) all the double sum members are averaged to zero (exactly like in Flory ideal chain derivation [9]). This is illustrated on the picture for two dimensional case.



After taking square root of $(\text{Angle})^2 = N \cdot (\alpha)^2$ (second member is zero after averaging and there N members of $(\alpha)^2$)

$$\text{Angle} = \sqrt{N} \cdot \alpha, E_n/E_o = (1-\alpha)^N$$

and the direct dependence of angle from z would be, since $E_n/E_o = 1/(1+z)$

$$\text{Angle} = \sqrt{\alpha \cdot \ln(1+z)}$$

However, since only 1/3 of all photons are scattered along any given direction (another 1/3 is in the perpendicular direction and another 1/3 is in the direction of light traveling) [this simple approach is for evaluation purpose only, the integration is necessary for more accurate result, similar to molecular physics] the formula should be adjusted for $1/\sqrt{3}$:

$$\text{Angle} = \sqrt{\alpha \cdot \ln(1+z)} / \sqrt{3} \tag{1}$$

{This $\sqrt{3}$ is because $\text{Angle} = \sqrt{N/3}$ – only one third of scattering is along the any chosen direction- and thus $\text{Angle} = \sqrt{N}/\sqrt{3}$ }. Application of this formular is in [10,11]. This approach has obviously many limitations:

1. There is no clearly described mechanism of energy drain directly proportional to energy E at all for the quantum mechanics (that is why the assumption $\Delta E = \alpha E$ for each step is an empirical formula, assumed to be valid because of the experimental data – for 4 orders of magnitude already the spectrum of the stars and galaxies is shifted exactly to this formula). In quantum mechanics the energy drain of photon may have no energy dependence (Raman scattering), E^2 dependence (Compton scattering) or E^4 dependence (Raleigh-like scattering assuming photon is generating gravitons through non-zero gravitational dipole quantization [6]). By no means may quantum mechanics propose any mechanism where energy drain is directly proportional to energy. Interestingly, such mechanism exists in classical mechanics – is somebody attribute to photon mass according to $mc^2 = hv$ formula and presumes the photon is flying next to gravitating object with huge mass M (say planet), the energy loss of photon due to deviation caused would be proportional to force created $F \sim G \cdot m \cdot M / r^2 \sim G \cdot M \cdot (hv/c^2) / r^2 \sim [G \cdot M / (c^2 \cdot r^2)] \cdot E$ and thus the energy loss in each gravitational interaction (there are so many of them en-route for 10-20 billions of years) is directly proportional to energy (and that would be exactly the red-shift as observed). This is essentially mechanism described in Zwicky original article [12]. Unfortunately direct assigning of mass to photon according to formula $mc^2 = hv$ does not work and was disproved long ago. There is an interesting idea about how this may still work but with some wild hypothesis expressed in [13] – every particle (both baryonic or not-baryonic) is obligatory both wave and particle with certain mass. It is switching from wave to particle all the time (kind of oscillating between being particle and being wave) – while photon spends almost his time as a wave it must from time to time being real particle and behave like particle with mass $m = hv/c^2$ because of energy conservation law. Proton is almost all the time is particle but from time to time is wave (that is why interference is observed and De-Broglie waves are real) and electron is mainly particle but more frequently a wave compare to proton (that is why the contrast, visibility of interference pattern for light is usually much higher, say many hundreds of visible strips for cheap laser, while the visibility or contrast in electrons interferometry is usually 5-7 maxima only visible even for very expensive apparatus). Anyway for tired light cosmology the idea of energy loss by photon directly proportional to energy is an important empirical supposition.

2. The scattering is assumed isotropic in all directions, which is for relativistic particle like photon is most probably not true. Exactly like the car driving on highway at maximum allowed speed mainly

collects water drops on the front window (with some inevitably present on side windows too) the idea of photon being scattered by any other particles, even also moving at speed of light, may lead to the assumption that majority of scattering is along the path of photon (and only tiny amount is on the sides). The sphere of scattering in the coordinate system moving with the speed of light may be spherical but in laboratory coordinate system it must be very elongated ellipsoid (and it is difficult to estimate how elongated). But some side scattering must be present anyway and this in principle allows to use the formulas above as approximation for initial fit of experimental results (and since the experimental result are not-conclusive anyway, that would be OK). As it will be shown below and in [11] the first calculations of value α from experimentally observed blurring of light in galaxies, supernovae, little red dots lead to the value of $\alpha=2*10\exp(-12)$ [10], what means that the particles on which the photon is scattered are enormously light (say femto to pico eV of total energy). They are either axions (the only modern particle candidate for dark matter with very small mass) or even tachyons. This is wild hypothesis because it breaks all the known laws of relativity but justifies the spherical scattering pattern and somehow correlates with general trend – heavy particle like proton or neutron is easy to put at rest, say velocity of 1 m/s, electron is very difficult – due to small mass even ultracold electron with temperature of 1 microKelvin is still moving with velocity of 5.5 m/s and photon in vacuum is seemingly impossible to cool for low speeds so far. So may be even lighter particle (with energy 12 orders of magnitude smaller than green light photon) will travel at superluminal velocity in space after all?

That light scattering expressed by formula (1) $\text{Angle}=\sqrt{\alpha*\ln(1+z)}/\sqrt{3}$ will inevitably blur the images of far objects. The surface brightness of the point object (like supernova at high $Z>2$) will inevitably drop, of course, and for very far galaxies which would be like point objects that surface brightness drop will demand enormously long accumulation times. Due to perfectly Gaussian distribution (number N is assumed to be trillions and more) all pure images of galaxies at very high Z would look like a perfect circle – all the information of the initial shape will be lost completely. Application of formula (1) to all visible objects at high Z is described in [32].

However, the perfection of the Gaussian distribution (due to enormously high N) allows the simple (but computationally demanding) algorithm of image restoration. Each initial point of the image (before scattering) is scattered according to simple law:

$$I=I_0*\text{Const}*\exp(-\gamma^2/2\sigma) \quad (2)$$

Where γ is the angle of scattering from formula (1) (that would be proportional to distance from the central point on the image) and σ is the same parameter which determines the scattering width (probability distribution function) for ideal chain [14, formula 2.80]:

$$P_{1d}(N,x)=[1/\sqrt{2*\pi\langle x^2 \rangle}]*\exp(-x^2/[2\langle x^2 \rangle]) \text{ and}$$

$$\sigma=\alpha*\ln(1+z)/3 \quad (3)$$

so the half-width of the Gaussian distribution is the function of only one parameter z (α presumed to be constant because of the original assumption of the energy drain directly proportional to energy of the photon). The restoration of the image for high z would be solution of the set of linear equations: each pixel of the restored image is spread according to formula (2) to the pixels in the raw image recorded by the telescope (may be after adjustment for the mirrors wrong curves and unwanted projectiles from bright stars elimination). For the galaxies with Z generating spread below the telescope diffraction limit (for James Webb Space Telescope that would be $z<0.144$) no restoration

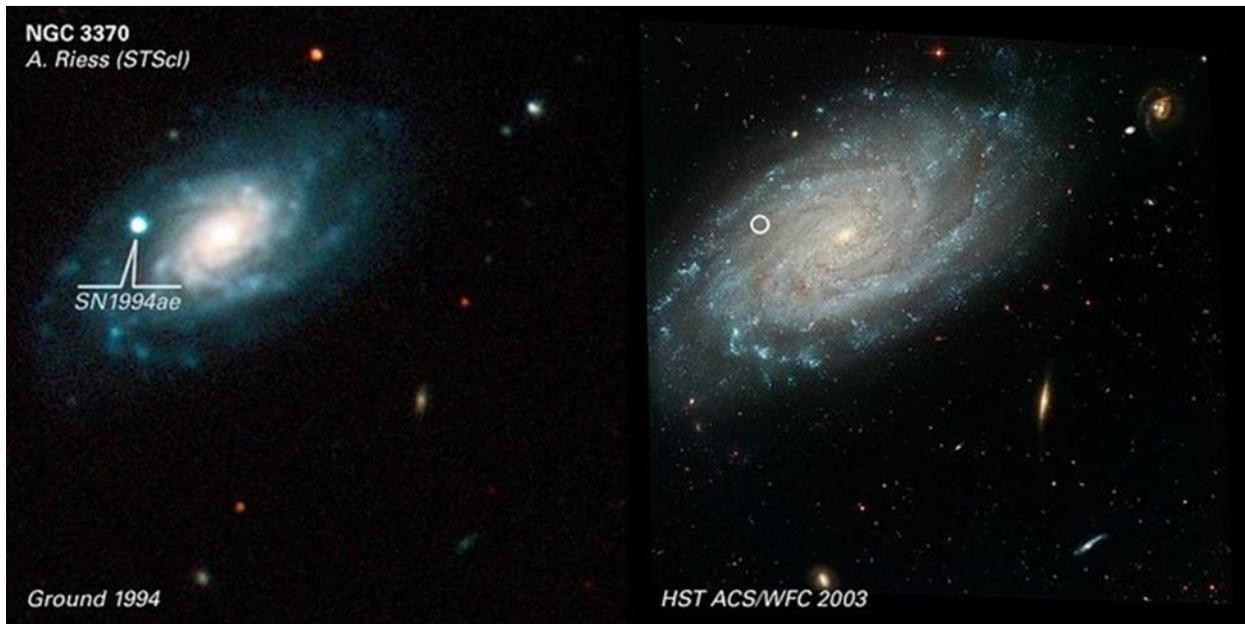
is necessary. For the relatively close galaxy with $0.144 < z < 1$ the optical information of the raw image (expressed in total number of pixels covering the galaxy) may be very high, the total number of pixels may be millions – calculation would need a powerful computer, but actually the sharpening effect will be small. For high $Z > 3$ due to finite resolution of both camera and telescope itself – angle resolution of telescope is λ/D , λ is the wavelength (1 μm and more for infrared), D is the diameter of the mirror (this mirror diameter can not be very large because it should be delivered to space) – the final number of pixels in the equation is not expected to be big (for the raw images of galaxies for $Z=7-14$ I would estimate it as $100 \times 100 = 10000$). This is because the angular size of the far galaxies is small and no sharpening procedure may break the diffraction limit of telescope (at $Z=14$ it is expected to be sharpened only by a factor of 4.5). Yet such sharpening procedure will allow to see more details for the furthest galaxies observed and allow to make new discoveries (once the Big Bang is not considered any more as important time boundary condition and galaxies far away presumably are similar to the closest ones, the change of images of similar galaxies may allow to discover subtle properties of light itself, undiscovered yet gravitational lensing (similar to weak lensing but even more subtle), dark matter new properties (while I am skeptical about the dark matter governing the too fast rotation of galaxies [6,13], it may turned out that such ultralight matter, scattering the light is actually very abundant and indeed responsible for many phenomena).

The model proposed describes how the energy is drained from the photon, but the direction of propagation is almost unchanged. If that α is very small, the value of N is gigantic, the total loss of the energy by photon may be very big ($z=13$ and up), but the deviation in the direction of travel is still very small and the photon behaves like it is losing energy but not scattered (exactly like Doppler-like phenomenon – reddening, but still delivering perfectly sharp images).

However, contrary to the case of infinitely small scatterings with reddening (Doppler-like case) for the case of very small, but finite ones the deviation of the light beam (blurring of the image) sooner or later should become visible. Quantum mechanics which must be applied in this case would not allow infinitely small photon scatterings anyway. Evaluation of such a mechanism was already done for the case of gravity [6] ($\Delta p/p_0 \sim 1/\sqrt{N}$ in [6]) and it was found that for the case of gravitation radiation loss of energy, which is consistent with the measured value of red shift for around 80 million light years away galaxy (energy loss of 0.5%), the value of $N \sim 10 \exp(37)$ and expected blurring angle should be $\Delta p/p_0 \sim 1/\sqrt{N} \sim 3 \times 10 \exp(-19)$ radian. This is way too small to be observed by James Webb Space Telescope. But recent reports about 90% of the galaxies having active galactic nuclei, galaxies which look like having big red circle in the center [15] what is impossible from the galaxy evolution point of view (if they have so big black holes earlier in history, why they all have small black holes now) makes a strong case toward idea of blurring of the light already visible. It means that some other, even stronger than gravity mechanism of blurring is here.

C) Blurring of the images of far galaxies – confirmation of tired light hypothesis?

What would be the direct observation of the light scattering confirming the tired light hypothesis based on statistical scattering mechanism looks like? The analysis of the known image blurring caused by atmosphere may be helpful here. Indeed, before the creation of the space based telescopes the Earth based telescopes were known to have limitation induced by atmosphere (that is why the best place for Earth based telescopes is away from light sources and as high as possible – Chile mountains, Hawaii mountains etc). The thinner the atmosphere the better the image. Still the direct observation of the same galaxy by the Earth based telescope and space based telescope reveal the problem (do not pay attention to the supernova, this is nothing to do with the discussion):



This picture is taken from [16]. The atmosphere-caused blurring blurs the bright center photons with much dimmer photons originated away from the center of the galaxy and makes the nucleus look gigantic. While the galaxy as imaged by the space based telescope shows no real active nucleus the image on the left looks like the galaxy is hosting enormous supermassive black hole with the size of active area almost $\frac{1}{4}$ - $\frac{1}{3}$ of the total diameter of the galaxy.

The supermassive black holes are known to exist relatively close to Milky Way and are resolved by Hubble telescope in the greatest details (Seifert galaxies). In [17] there is a picture of NGC 6573 (only 150 millions of light years away from Milky Way) made by Hubble [17]. But even this known as having supermassive black hole galaxy does not have really big bright central spot. May be only around $\frac{1}{7}$ - $\frac{1}{5}$ of the total diameter of the galaxy.

Therefore from the point of view of direct observation of scattering any picture made by space based telescope which would look like the picture of NGC3370 (see above) made from Earth based telescope (the image is known to be subject of scattering) would create the necessary proof of the light scattering caused by something in the otherwise complete vacuum.

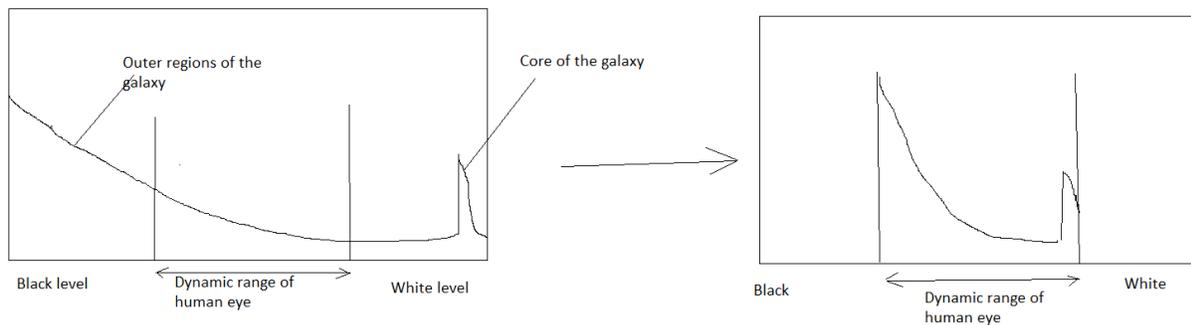
Recent debate about the abundance of the supermassive black holes 13 billions of light away observed by James Webb Space Telescope demonstrates the photos exactly like expected from the point of view of scattering present [15]. Not only the presence of such supermassive black holes in the “early” universe contradicts to any reasonable model of Big Bang (this is indirect disproof of the Big Bang), but the appearance of the galaxies itself causes huge doubts about interpretation. The bright area is reaching $\frac{1}{3}$ or even $\frac{1}{2}$ of the total diameter of the galaxy, well above what is expected for the space based telescope (may be $\frac{1}{7}$ - $\frac{1}{5}$ of the total diameter) and even larger than the known effect caused by the Earth atmosphere. Such extra super massive black holes are explained by the new mechanism of the formation of very large black holes from primordial black holes (instead of normal mechanism of merging). The authors forgot that if the black holes are so huge and abundant in the “early” universe they must be absolutely enormous (and even more abundant) in the present day universe, yet the best Hubble found is photographed in [17].

The opposing mechanism of the unusual look of “early” galaxies is of course the scattering of light. Despite the mechanism is not known, the final effect looks like the influence of the Earth atmosphere on the image in Earth based telescope: the bright but small (normally small) core is mixing the photons with the rest of the galaxy and slowly “spreading” toward the end of galaxy. For really strong scattering the whole galaxy would look like one uniform unresolved patch of light.

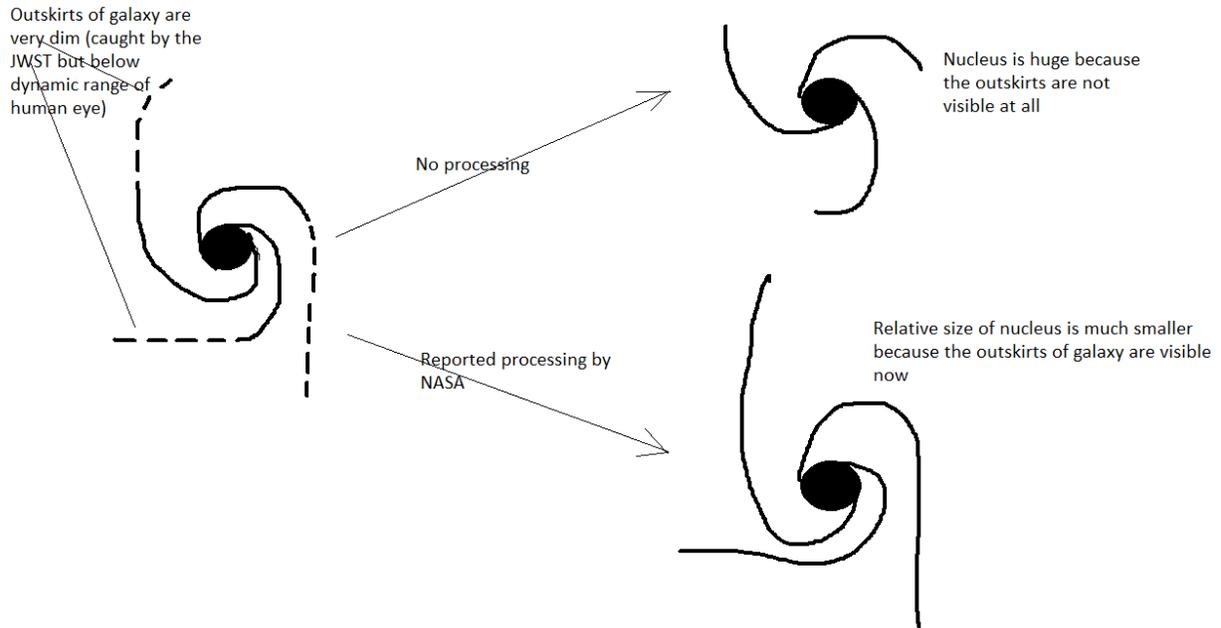
The remaining question is about the ultimate resolution of the telescope itself – if the resolution is approaching the limit but no scattering is present, how the galaxy should look like? The modelling of artificial red shift was already performed and published in many articles [18]. As it is possible to see the resolution is poorer and poorer, yet the center of galaxy is not “spreading”. For even poorer resolution with assumption of now light scattering the bright center of the galaxy will go to the central pixels of the digital camera only while having the rest of the galaxy looks dimmer and dimmer. The last unknown factor here – it is possible that the images published in [6] are not raw images but rather images already processed by some kind of smoothing filter which of course will make the central core looks larger to make the image looking better. According to the NASA webpage a more gentle procedure takes place:

“A mathematical function is used to increase the brightness of the darkest pixels, while maintaining details within brighter pixels in the image. Stretching and compression are required because Webb’s images have a vast dynamic range.” [20]

From my perspective this procedure should not greatly mix the core pixels (presumably the brightest) and near core pixels (which are bright enough to be seen but not barely bright to be “enhanced”). Probably the mathematical algorithm described makes the histogram of brightness of pixels for the galaxy looking like this:



And this procedure is not moving the darker pixels into the core pixels. Rather it makes the opposite – make the core visibly **smaller** because the otherwise invisible outskirts of galaxy are enhanced:



Thus the postprocessing should make the relative size of the center of the galaxy smaller, not larger because the otherwise not visible very dim outskirts of the galaxy are now fully visible.

It only emphasizes that the “supermassive black holes” abundant in “early universe” [15] is in reality the first direct observation of the light scattering which is expected to cause such an effect. The galaxies are having the very large nucleus because the light is scattered in the vacuum. The reason is of course not electromagnetic interaction but something else [6,19]. Analysis outlined in [6] for gravitational interaction demonstrates that it is too weak for James Webb telescope to reveal it (many orders of magnitude weaker, JWST is still expected to deliver absolutely clear images). Thus most probable reason is fifth force – stronger than gravity but many orders of magnitude weaker compare to electromagnetism (some researches long ago suspected the fifth force being present in the so-called “gap” – a huge separation in strength between the gravitational and electromagnetic forces).

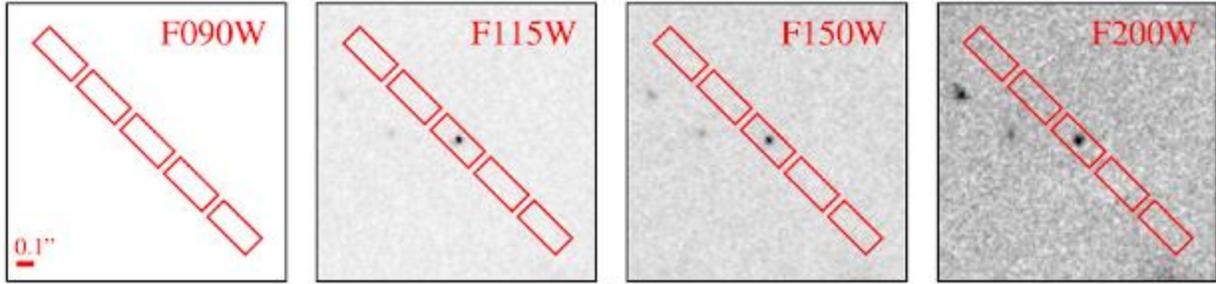
D) Supernovae angular size and brightness at higher z as observed by JWST – second direct confirmation of the presence of light scattering. “Dark energy” and accelerated expansion of Universe is an erroneous interpretation of the Hubble data.

What would be the other space objects to demonstrate the light scattering if it is so strong that James Webb Space Telescope may already observe it (not as weak as predicted in [6] based on the idea of gravitational dipole energy loss? The very good such objects are supernovae [21] – those are standard objects in the Universe, extremely bright (may outshine the whole galaxy at its maximum brightness and also extremely compact). Despite there are many types of supernovae with respect to curve plot (and that would be important later when the supernovae 1A are considered – the standard candles) they all are relatively compact objects. Since the supernovae is well investigated and now observed by James Webb Space Telescope up to $z \sim 4-5$ it is especially good standard object to check the telescope tuning – even from point of view of standard cosmology (the Universe is 13.6

billions of years old) those supernovae can not be considered as “primordial” supernovae, they must be as standard as the close one and thus all the properties are precisely the same (and of course from the point of view of infinite and eternal Universe they are the same and really standard objects). Why the supernova is a very compact object (not compare to stars, of course? Because it is well researched object and it is a well known fact that the maximum brightness is reached at around 24-40 days after the explosion started [21]. The supernovae rate of expansion is well known and it is established fact that the plasma propagates at a speed of around 0.1c in a perfect sphere shape [22]. It means that at the time supernova is discovered (usually close to the maximum brightness, especially at higher z) the real size of supernova is not very large – merely 2.4 to 4 light days (6.2×10^{13} to 1.04×10^{14} meters) or only 10-20 times larger than Pluto orbit radius. Using the formula $\alpha = \lambda/D$ for the optical resolution of telescope we have the angle $\alpha = 3 \times 10^{-7}$ rad ($\lambda = 2 \mu\text{m}$, $D = 6.5 \text{ m}$). (This is diffraction limit, the camera itself may have better resolution, but laws of physics tells that no two objects separated less than α may be really resolved). It means that the real resolution of supernova at around maximum brightness is only possible at a distance less than $\sim 2-3 \times 10^{20}$ meters, or $\sim 2-3 \times 10^4$ light years. That corresponds to merely $z = 1.6 \times 10^{-6}$ to $z = 2.3 \times 10^{-6}$ [23]. Even the supernova in Andromeda galaxy can not be resolved during the maximum brightness even by James Webb Space Telescope. Of course the supernova at a close galaxy will not be observed as a point object because of enormous brightness – it will saturate the camera and it will have the visible circle much larger than the diffraction limit and even have the visible “projectiles” (see first picture in [21], for example) because the mirror of telescope is not ideal. However, for any reasonably high z (and James Webb Space Telescope may see them already at $z = 3-4$) the supernova is not visibly bright (no saturation of the detector) and **by no means may be resolved optically (must be at the diffraction limit of a telescope)**.

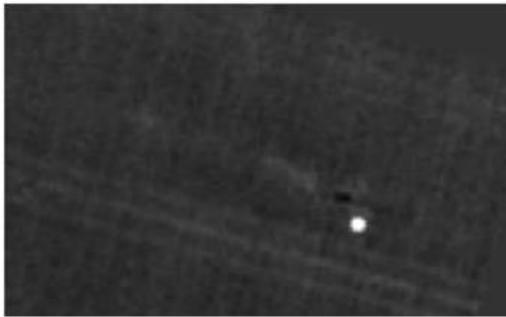
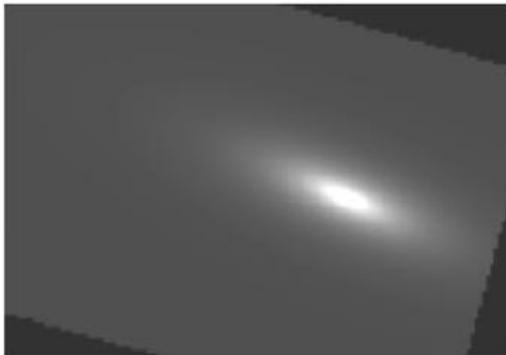
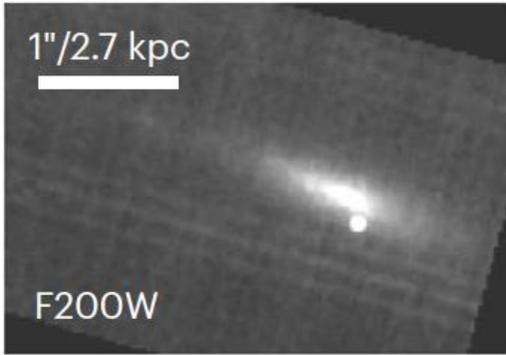
That simple geometric optics consideration makes the supernovae a valuable resource for the search of light scattering. They are so compact and so bright objects that even the slightest deviation in the observed size from the diffraction limit of telescope means something wrong with light – it is scattered and the image is blurred. Another important consequence – supernova must be observed as a perfect circle (any deviation means the light is experiencing micro-lensing – the arc is formed instead of circle). Thus the best way to see the light scattering is to see the images of supernovae at high z as observed by James Webb Space Telescope – are they at the diffraction limit of the telescope?

At first it is necessary to check the optical resolution of the telescope itself. When people were researching recently discovered “little red dots” (actually blurred by light scattering images of galaxies so small that instead of normal shape of the galaxy just the diffraction-limited circle is observed) they also found on James Webb Space Telescope generated images the so-called brown dwarfs which belong to our Milky Way galaxy ($z=0$) but are so feeble stars that are not saturating detector and looks exactly like far away galaxies [24,25]. Those brown dwarfs are easily identified by the spectrum, but since they are generating only a small amount of light compare to usual stars like Sun, they are not having usual “projectiles” easily visible for stars from our galaxy on images made by James Webb Space Telescope (that is why they are “masquerading” like the galaxies at high Z-shift like 7-9). They are indeed recorded at the diffraction limit of the telescope (the picture is taken from [25]).



In this figure the brown dwarf is shown as black dot in the center of the image (squares are 2.4"x2.4" and on the first image the scale is shown). The angular size of the brown dwarf for filter F115W is 0.058" or 2.8×10^{-7} rad. For the center wavelength of 1.15 μm the angular resolution (diffraction limit) of JWST would be $1.15 \mu\text{m} / 6.5 \text{ m} = 1.8 \times 10^{-7}$ rad. It is clearly seen that the angular size of brown dwarf is close to the diffraction limit of the telescope. For wavelength of 2 μm (F200W filter) the angular size is around 0.096" or 4×10^{-7} radian, close to the mentioned above 3×10^{-7} radian. It means that for the small point-like objects which must have no light scattering (see the formulas for tired light above) indeed no scattering is present. Telescope itself is working perfectly and demonstrating resolution close to what is expected.

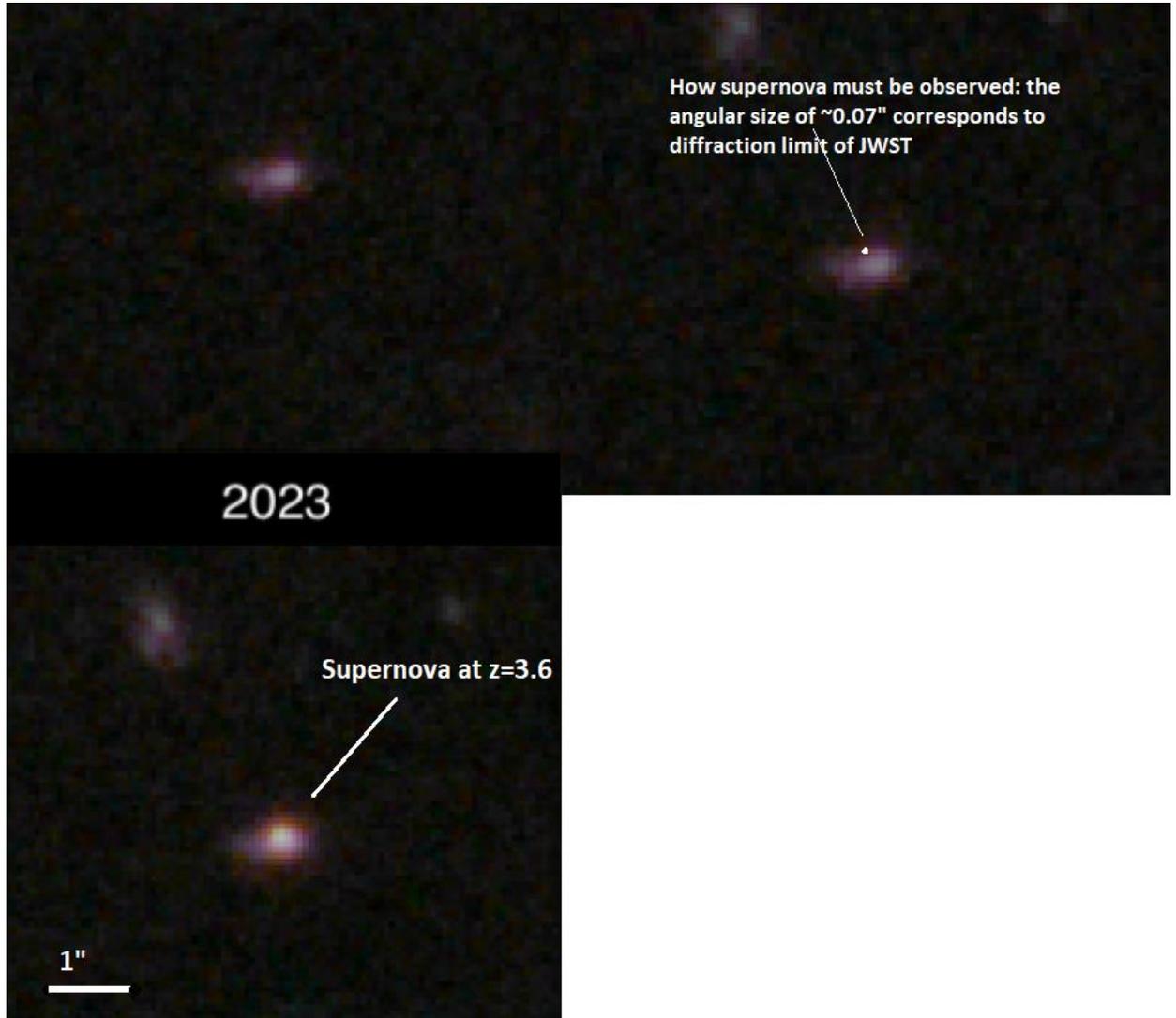
The second check of the James Webb Space Telescope would be a look onto the supernova closer to Milky Way compare to $z=3-4$. It means that if the formulas outlined above are true and supernova is not superbright to saturate detector and demonstrate "projectiles" it would be also close to the diffraction limit. The convenient supernova would be one at $Z=0.151$ published in [26], see the picture below. In this picture taken from [26] and already used in [27, 28] on the top is the image for F200W filter (2 μm wavelength) for galaxy and supernova, in the middle the galaxy from previous year image and at the bottom the difference (supernova itself). As the analysis done in [27,28] demonstrates, the angular size is 0.111" or 5.38×10^{-7} rad, close to the expected diffraction limit of telescope of 3×10^{-7} rad (some scattering is actually expected to be already present because the Z for this supernova is not really very close to 0).



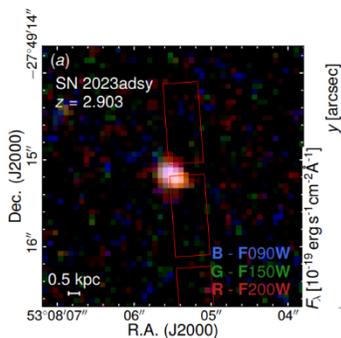
Again it follows that the James Webb Space Telescope itself is working exactly as expected, no problems with mirror or camera – if the object must be recorded at the diffraction limit, it is detected at diffraction limit, no contradictions from device performance is expected.

To the stark contrast to the supernovae and brown dwarfs the supernovae at high Z are visibly much larger than they should be (and from naïve point of view they should be smaller – they are much further, and from correct point of view must be of the same angular size equal to the diffraction limit of the telescope). The numerous examples are published in many places and already referenced [7, 27-32]. In original publications the unusual size of those supernovae is not mentioned and not discussed [33,34]. Supernova 2023adsv was mentioned as having “gargantuan” size in one comment, however [35]. As it was already discussed above, by no means the far supernovae may have the size resolved – after all, this is just a star, despite exploded. Even taking into consideration the inevitable for Big Bang cosmology Tolman effect, the visible size of the object at $Z < 4$ may be at most 2 times larger, that makes no difference for so distant objects – they must be observed at the diffraction limit of the telescope. How the supernova at $z=3.61$ must look like and how it is observed

is shown below (the image is taken from [33]): in the upper left picture the galaxy image from 2022 is shown, below the image from 2023 with supernova present and on the right the image of supernova at the diffraction limit of James Webb Space Telescope. The light blurring due to scattering is clearly seen.



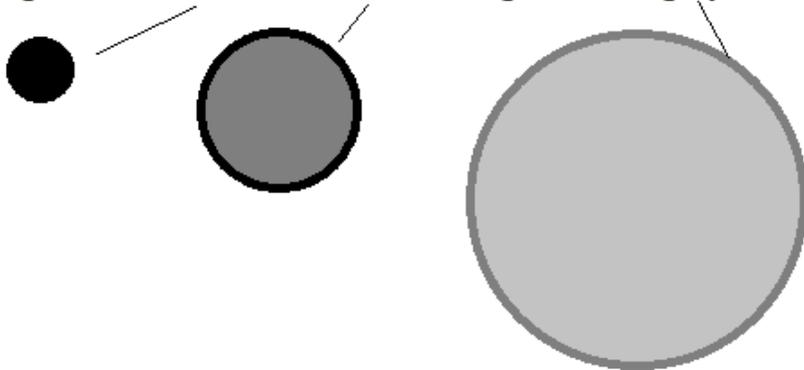
A similar huge in size supernova is reported for $z=2.9$ [34], the image is taken from [34].



That supernova 2023adsy has a visible size of around 0.3-0.4" instead of ~0.1" (red color corresponds to 2 um wavelength used in calculations) – way too much for the diffraction-limited image. The idea that in reality the telescope is trembling a little due to very high time of accumulation compare to the close objects like brown dwarfs and thus the overall resolution is poorer was discussed in [30,31] – there are clearly visible objects with smaller angular size compare to far supernova (some stars- “trespasses” from the outskirts of Milky Way), which means that the overall resolution of telescope is fine (otherwise it would not be possible to observe such objects, since the trembling would blur them simultaneously). Instead, only confirmed point objects from very high distances (supernovae at high z confirmed by spectroscopy) are blurred, not the local objects. Again and again it is clearly seen that the light from very far objects is blurred somehow. Another, more instrumental possibility of larger angular size – saturation of the detector due to enormous brightness of supernova also can not be considered at high z – despite supernova can outshine the whole galaxy at maximum brightness, those galaxies are so far away that some accumulation necessary to image them – by no means detector saturation may be an issue.

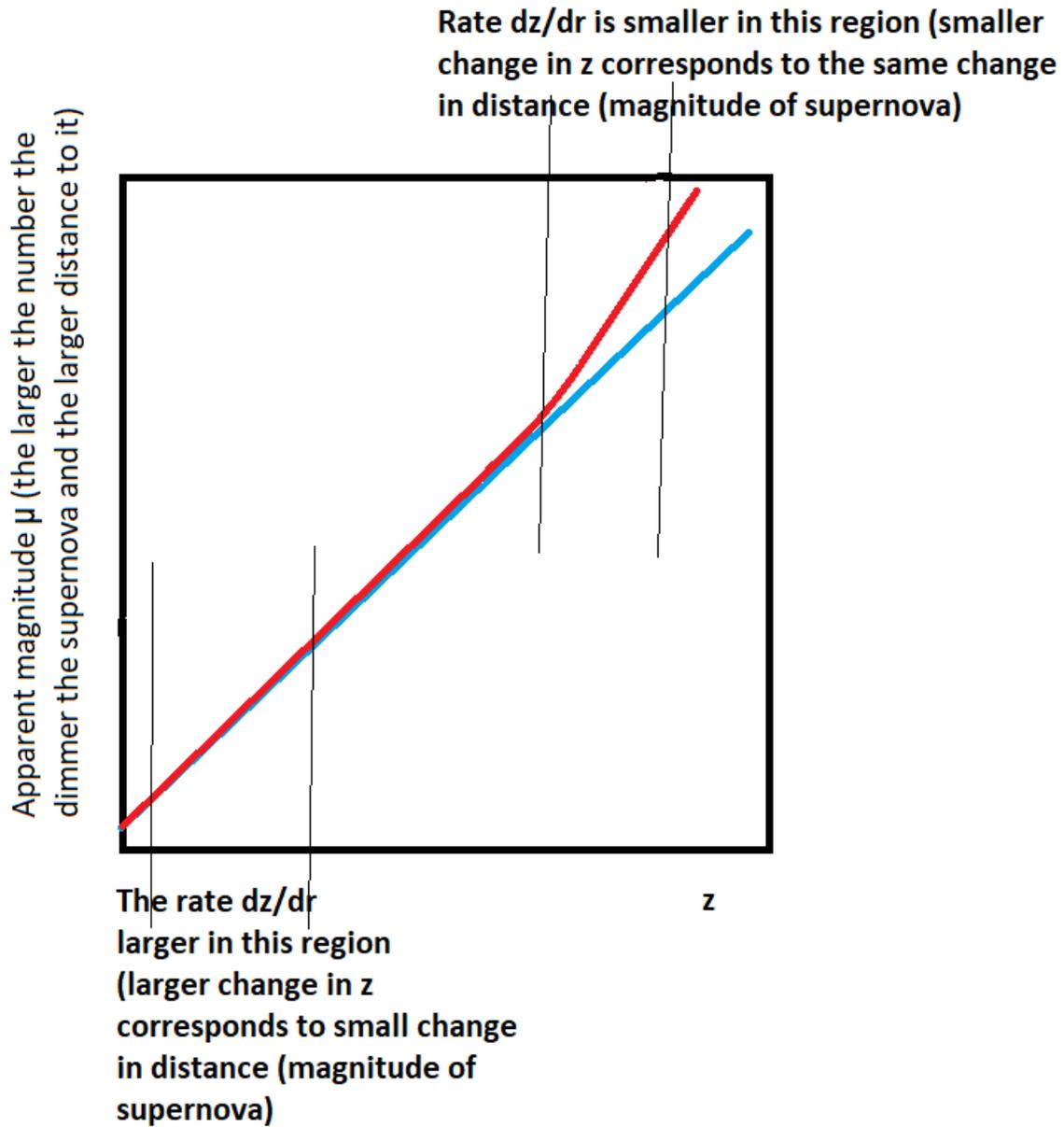
Supernovae of type 1a were considered as standard candles for long time. During Hubble time it was found the small change of the apparent luminosity of supernovae at $Z \sim 1-1.5$. Since from Einstein’s time the mainstream of theoretical interpretation was the search for any discrepancies in cosmic behavior as due to space-time peculiarities the explanation was coined that the rate of expansion is accelerating and dark energy is necessary to explain it. In the case of the absoluteness of the light behavior (no scattering is allowed except for already known mechanisms) that would be correct conclusion. But in the case of just observed light scattering a different interpretation of the famous experiment on supernovae type 1a which lead to idea of “dark energy” [36] is possible [37,38]. The new interpretation is present on the picture below:

The same number of photons (determined by the size of the mirror of the telescope) is spread into larger and larger circle (the smallest one is the diffraction limit of telescope, the circle can not be smaller) and thus the brightness of the circle becomes smaller and smaller (and the corresponding magnitude or distance modulus larger and larger)

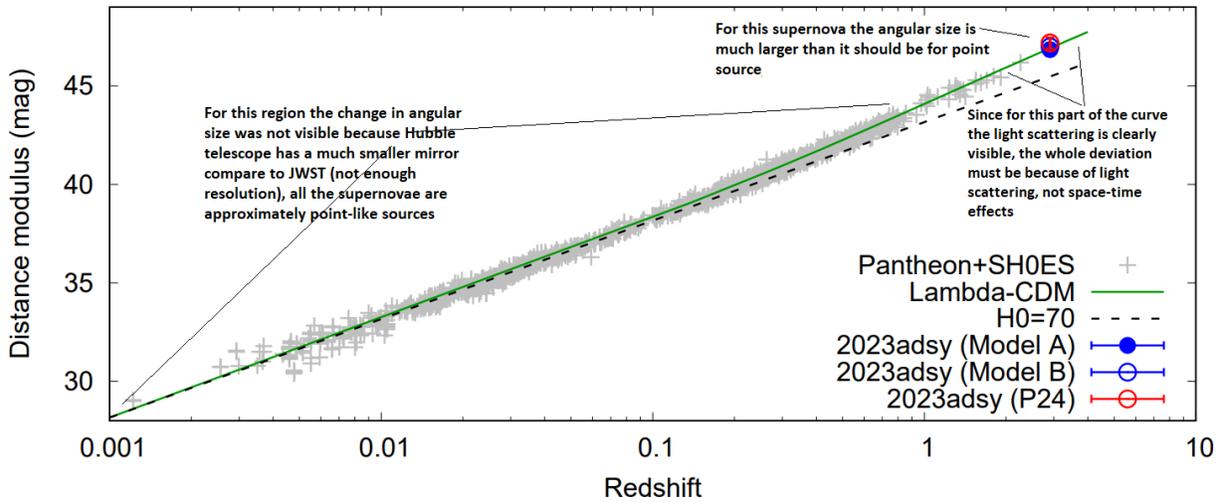


Since the observation leading to the idea of dark energy merely means that supernovae are dimmer than they should be if the “expansion of the Universe” rate would be the same, the same dimming may be explained by simple light scattering (but if such light scattering is presumed to be absent,

such simple explanation may not be even considered). In this case the deviation would be explained as shown below.



The direct observation of the light scattering on supernovae (any type, not only 1a) will make obsolete the “dark energy” idea. This is especially well seen when the astronomers are trying to unite Hubble Space Telescope and James Webb Space Telescope data on supernovae type 1a in one plot [39]:

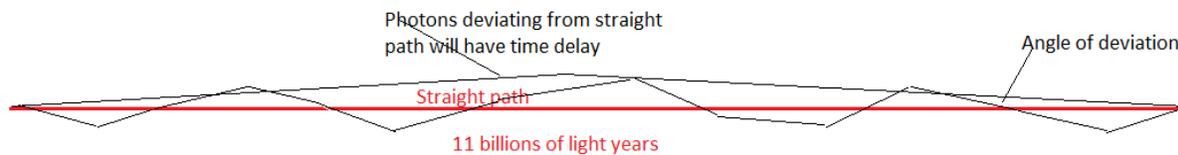


As it is mentioned in [38], simple logic arguments that since the higher z points of this curve are visibly, clearly due to light scattering, the whole curve must be because of light scattering, not “dark energy” and old findings of Hubble Space Telescope must be re-interpreted. It also means that despite being interpreted wrongly, the effect of light scattering was already observed by Hubble Space Telescope and the result itself was already published [36]. Such presence of the similar result (if interpreted correctly) means the deep consistency of the idea (if real, it can not be only present in one phenomenon, on the opposite, it should be revealed eventually everywhere, but in some case the effect may be very small).

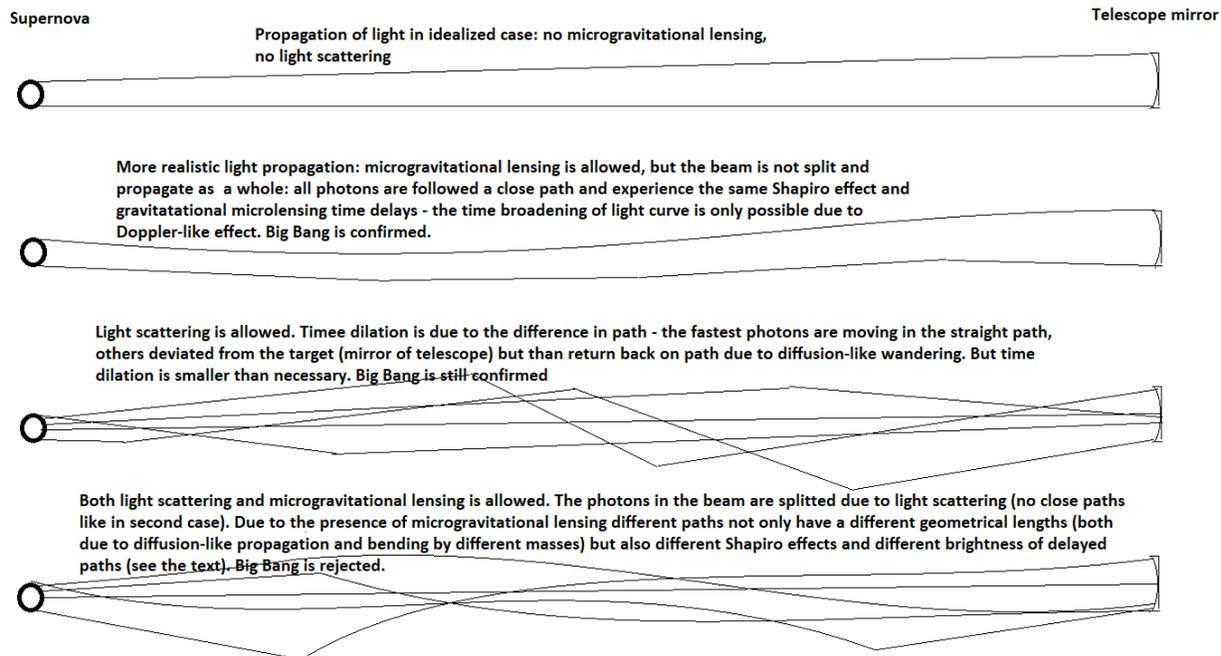
E) Tired light hypothesis in combination with weak lensing may generate enough “time dilation” – implications for observed already light curves for supernovae at high z.

One of the known phenomenon considered as important confirmation of the Big Bang is the observed dilation of light curve for standard light curves for supernovae type 1a. Indeed the very strong problem with tired light theories in which light is losing energy but not scattered is the clearly observed and confirmed change in light curve behavior [40]. The statistical approach to the tired light described above do predict time dilation of the event – because some photons may go almost along the straight line (deviating from the straight line and returning back) and some photons may deviate from straight line very much and then return back and be caught by the telescope. In this case the second group of photons will travel much longer distance and due to the speed of light being almost exactly c create the lag of time and thus time dilation [5].

Evaluation of this lag was already done in [5] and may be done as follows: for $Z=1$ angle from formula (1) is $\frac{\sqrt{\alpha \ln(2)}}{\sqrt{3}} = 6.8 \cdot 10^{-7}$ ($\alpha = 2 \cdot 10^{-12}$) [10]. The current distance to $Z=1$ supernova (not Big Bang cosmology with distance of $7.731 \cdot 10^9$ light years, but for static universe) is $11 \cdot 10^9$ light years. For evaluation it is assumed that light goes in two paths – straight and deviated in two dimensions).



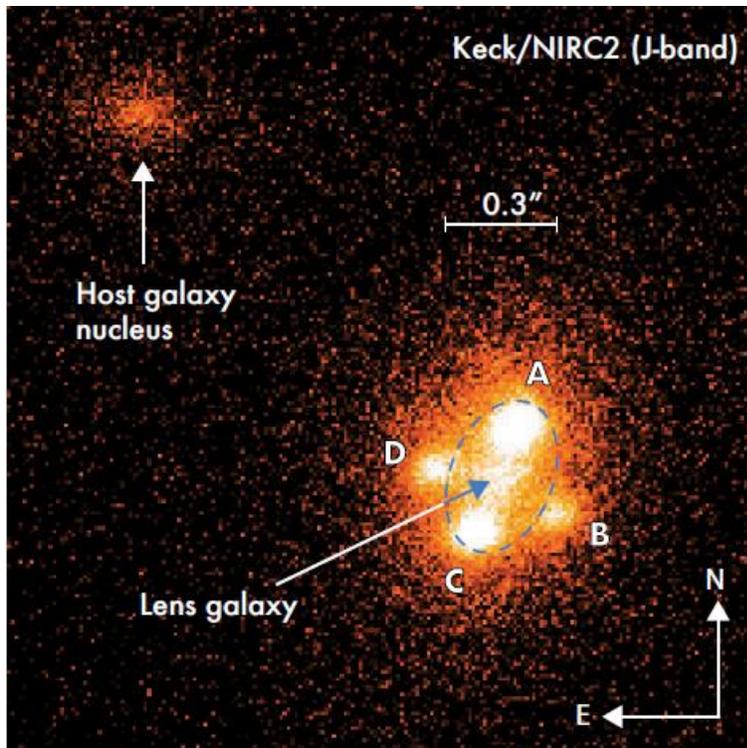
Since the light is scattered from the direct path in two dimensions, for the evaluation the spiral-like path along the cone with length of 11 billion of light years and angle of $6.8 \cdot 10^{-7}$ radian is considered. That length would be approximately the length of hypotenuse of the triangle with one cathetus of 11 billions of light years and second one of $\pi \cdot D$ length with $D = 11 \cdot 10^9 \cdot 6.8 \cdot 10^{-7} = 7.48 \cdot 10^3$ light years and $\pi \cdot D = 2.35 \cdot 10^4$ light years. The time difference would be the difference between hypotenuse and longer cathetus, which would be $\frac{1}{2} \cdot (\pi \cdot D)^2 / 11 \cdot 10^9 = \frac{(2.35 \cdot 10^4)^2}{2 \cdot 11 \cdot 10^9} = 0.0251$ of year which is 9.6 days (evaluation in [5] gives 4.4 days). Because the light of supernova will be a mixture of the light arrived directly from straight path and light which first goes away and then returned back to path to telescope mirror the overall light will be sum of many photons with many shifts and thus light curve will be broadened. Problem is that the light curve broadening for supernovae type 1A at $Z=1$ is well known to be 20-24 days which is larger than any of the evaluations. The accuracy of evaluation is not good of course, but there is another interesting way how the possibility of light scattering (even very small one) may dramatically influence the light curve – the microlensing possibility. In this case the inevitably present small galaxies invisible by direct observation but present in the path will not split the beam completely (classical gravitational lensing, Einstein cross), but merely distort the image and generate much large time delays compare to the possibility of light scattering alone (in the case of simple microgravitational lensing no added time delays other then Doppler-like for Big Bang Universe is expected).



In addition to complex time delays for the different paths in the case of both scattering and microlensing different Shapiro effects are possible and different brightness of the different paths (one effect enhances another, due to scattering the photons are moving much further from direct path – not only for the diameter of mirror, but up to something like 7000 light years away – see estimation above – thus allowing microlensing through small galaxy on the way and generating much larger time delays for different paths around such an object). This idea is described in [41,42].

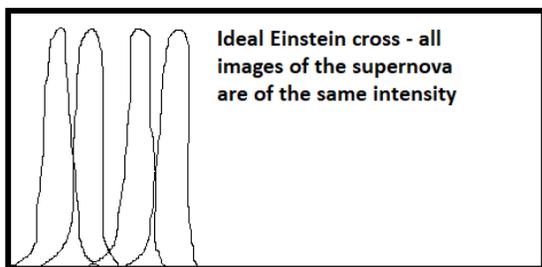
Due to the presence of microlensing the real image of the supernova at $Z=1$ and beyond would be consisting of many very small dots (provided the resolution of the telescope is 100 times better than Hubble). This is because the smaller masses (compare to strong gravitational lensing which generates visible Einstein cross) will generate many Einstein crosses but they all blurred together due to lack of the resolution. Interestingly the time dilation may be actually observed even in the case of the absence of light scattering and absence of Big Bang (no Doppler-like effect is necessary) – because the already observed Einstein crosses are demonstrating huge difference in time of arrival of light for 4 different images (up to 180 days) and possibly smaller, hardly resolved Einstein crosses will give the time difference comparable to the observed time broadening of the supernova light curves (if Einstein cross is not resolved, all four images will give actually one but photons from different paths arrive at different time, the observed light curve is actually of sum of 4 light curves time shifted with respect to each other – it will inevitably be time broadened).

In [43] the excellent example of hardly resolved Einstein cross is shown with lensing galaxy much weaker than the supernova images:

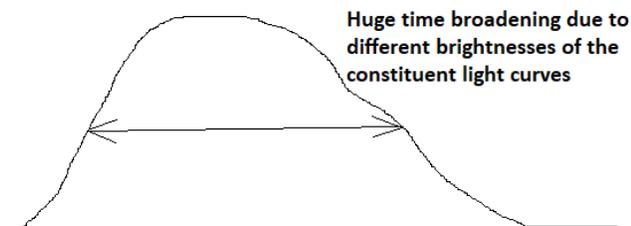
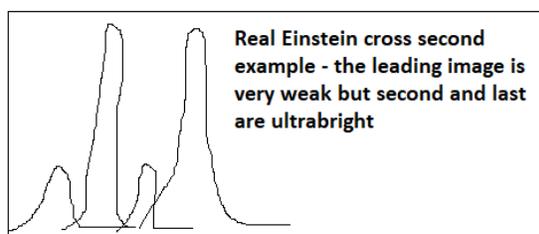
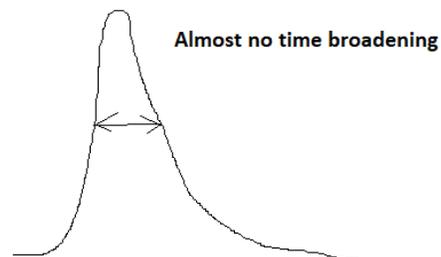
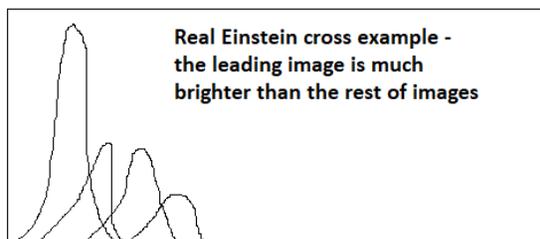


If the resolution of the telescope would be just a little worse, this supernova would look like one image. But it would be actually consisting of 4 overlapped images with different times of arrival and thus the observed light curve would be much broader than each of the constituents. One of the explanations of the supernovas huge visible angular sizes [27] (up to 6 times larger than diffraction limit of the telescope at $z=3$ as observed by JWST) which **preserves the Big Bang** is exactly this one – the real image is merely the superposition of multiple Einstein crosses due to weak gravitational lensing (unresolved because the resolution of JWST is limited). In this case however the time broadening of light curves (seemingly confirming Big Bang due to Doppler like effect) must be even more pronounced – first because of Doppler effect (proportional to $1+Z$) and second due to overlapping of different images which have different paths and Shapiro effects (proportional roughly to \sqrt{Z}) – in total the time broadening of light curves would be so big that the supernovas already at $z=3-4$ would shine for many months. Such enormously large time dilation may be already dismissed – even preliminary images of JWST (for $z\sim 3$) made with time separation of months are not showing such ultra-persistent supernovas.

The last effect which may contribute the most (Shapiro effect is of course present but usually considered as being around 10% of the time delay due to elongated path) is the different brightness of the different constituents of unresolved Einstein cross. Indeed, this is easy to see on the picture above – no Einstein cross is ideal, usually one component is very bright and one is very dim. If the Einstein cross is unresolved, this may contribute strongly to the observed time broadening of the supernova making it very broad or very narrow (almost as narrow as without any gravitational lensing effect). It also is different for different wavelengths, making matter even more complicated. The great review on this topic is [44] where the effects of microlensing for supernovas at $z\sim 1$ were estimated as leading to around 10-14 days difference in time broadening (actually enough to explain the “time dilation” for supernovas even without any Doppler-like effect).



Time, days



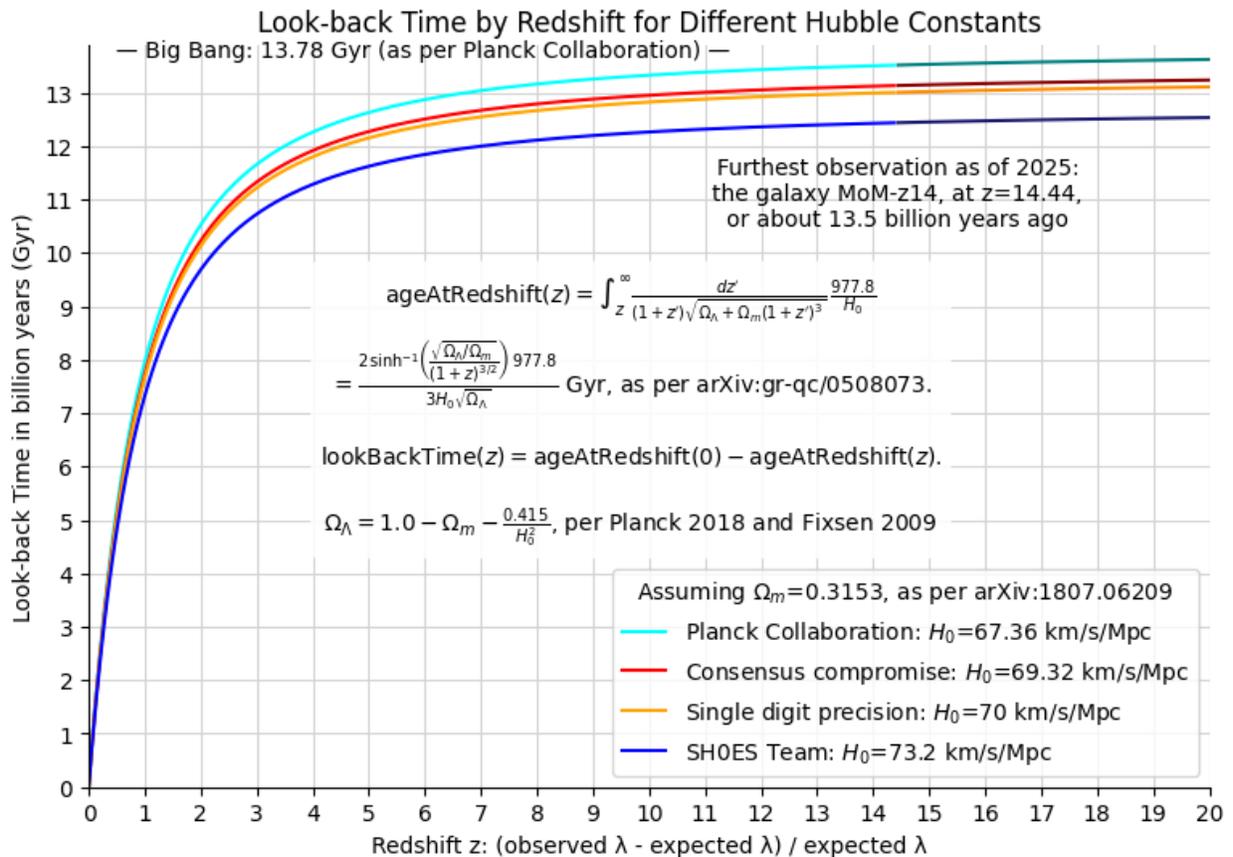
This effect is mainly contributing to big scatter of the observed time dilations and should be averaged on multiple observations of supernovae. Unfortunately to make such a statistics even at $z \sim 1$ thousands of supernovae are to be recorded with light curves (unbearable task even for Hubble plus Earth based telescopes). And for JWST so far only observations of the supernovae are made (and no reported light curve is measured). Meanwhile this effect by accident may generate extremely broad in time light curve for supernova, seemingly confirming Big Bang, but in another accident may completely reject Doppler-like effect – the scattering of data may be big. Published data on light curves indeed confirmed the big scattering in observed “time dilations” for supernovae at $z \sim 1$, but whether it is due to such brightness difference mechanism (of unresolved Einstein crosses) or due to inevitable experimental errors is not clear at this time.

While the initial estimation of the time broadening of the light curve of supernova gave a smaller than necessary value (4.4 days or 9.6 days instead of 20 days) if other effects are taken into consideration the tired light hypothesis may create big enough value. As it is a typical case in many complex scientific issues, only direct experiment may differentiate the Big Bang and Tired Light in the question of “time dilation”. Big Bang and Doppler-like effect must generate at least $1+z$ time broadening (or may be even larger if microlensing and unresolved Einstein crosses are taken into the consideration), while Tired Light must generate much modest time broadening approximately like \sqrt{z} . Already for $z \sim 3-4$ (actual supernovae observed by JWST in 2023-2024) the difference is huge and even with discussed brightness-generated errors should be easy to differentiate. This experiment (direct measurement of light curves for supernovae at $z \sim 3-4$) may be considered as one of the

simplest and possible at the present time (beginning of the 21st century) ways to New Physics. Hopefully JWST devotes enough time to the light curves of supernovae with $Z > 3$ – even one but perfectly recorded light curve should be enough.

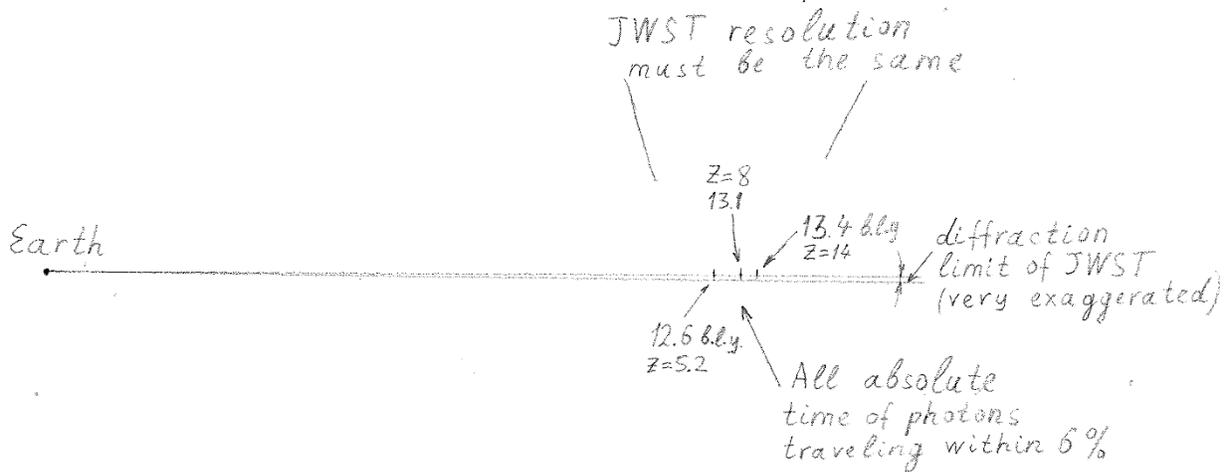
f) Little red dots and objects at Z>10 – why all the record breaking galaxies are circles?

Next interesting observation is about little red dots and far galaxies – especially record breaking galaxies. But first it is necessary to emphasize that the most common pictures of the evolution of the Universe (from point of view of Big Bang) is very misleading. When measured as a function of Z it makes the perception that the galaxies at z=1 are somewhere on the right side of the plot, galaxies at Z=3-5 are in the middle and galaxies at Z=8-10 are somewhat close to Big Bang and epoch of re-ionization. But in reality the observed distances (from Big Bang point of view) are very non-linear function of z with almost all galaxies are placed at the “shell” at the distances between 10 and 13 billions of light years. The correct function is shown here [45] (picture copied from [45]):



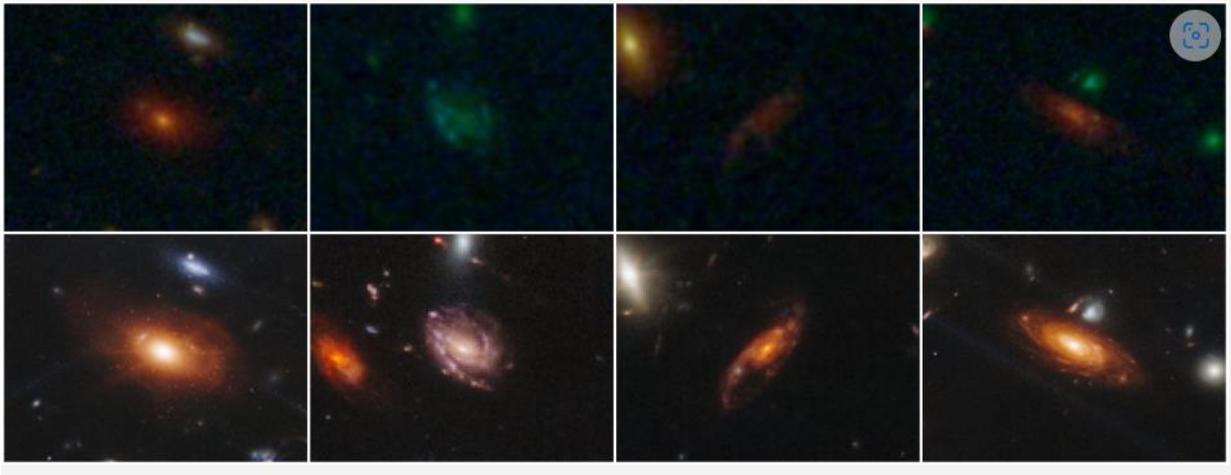
In my publications [46,47] I demonstrated that the observed distance for far galaxies are within 5% from each other for very high span of Z:

Big Bang geometric optics consideration (no Tolman effect for simplicity)

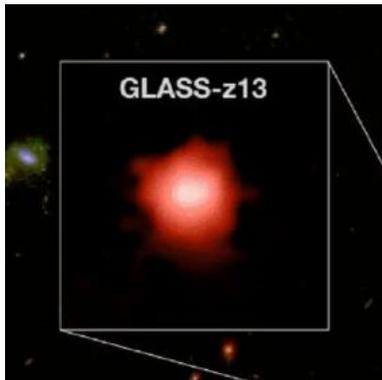


Since the data presented by telescope is the only visual data available it is clear that all the galaxies from $Z \sim 5$ and up should have approximately the same resolution (even in the absence of Tolman effect, with Tolman effect the galaxies at high Z are spread 2-4 times and must have better resolution compare to say $Z \sim 5$). This is because of the approximately the same time of photons travelling and the assumption of Big Bang cosmology that light is forbidden to scatter during travel (only being absorbed and re-emitted, which means the photons are lost for observations). As it is demonstrated in [46,47] there is a dramatic difference between them – while galaxies at $Z \sim 5$ are in good resolution and many of them ovals (must be because the most probable projection of elliptical or spiral galaxy is from the edge or close to edge) the majority of record breaking galaxies at $Z=10-14$ (and all little red dots) are circles. But resolution of the telescope from the simple geometric optics laws and from the major assumptions of Big Bang [45] must be the same. This simple fact is explained by the proponents of Big Bang as the proof that all the ancient galaxies are extremely small, ultra-luminous and all have the real shape of balls (what is impossible from the other ideas of Big Bang cosmology, that due to the vicinity of Big Bang the galaxies must be irregular, elongated, wrong shapes because being formed in turbulent Universe with a lot of energy from recent rapid expansion and most probable shape is banana-shape [48]). Banana-shape galaxies are because the linear fiber-like stretches of dark matter are necessary to help first galaxies to form – a reasonable assumption for the turbulent start of the Universe. In short – the primal galaxies must be mainly elongated and observed by any other shape but circle (because as it is shown above the resolution of them is almost the same as for galaxies with $Z \sim 5$ and only 1.3 times worse than galaxies with $Z \sim 1$, which are greatly resolved). Yet they all simple red dots and circles with irregular shape. As it was described in [46,47] there is no problem for tired light here: the galaxies at $Z=15$ are 4 times further compare to $Z=1$ (and not only 1.3 times further). Obviously even JWST telescope have no such resolution to see them clearly - they all are circles because of the light scattering (all the information about shape is lost completely, they are demonstrating light scattering properties and observed at all merely because they are by chance are ultra-bright).

Comparison of images delivered by Hubble Space Telescope - predecessor of James Webb Space Telescope (JWST) – and JWST demonstrates enormous increase of resolution for $Z \sim 0.4$ (5 billions of light years away) [50], image taken from [50]: upper row – Hubble, lower row – JWST.



With this improvement in resolution the images of the galaxies at $Z=5-14$ (which are according to Big Bang cosmology are placed on kind of shell with distance of only ~ 2 times larger compare to $Z \sim 0.4$) must be resolved in much details (and be “banana” shaped or irregular shaped), yet JWST delivers the dull circles again and again [46,47] like this galaxy at $Z=13$ (image taken from [50]):

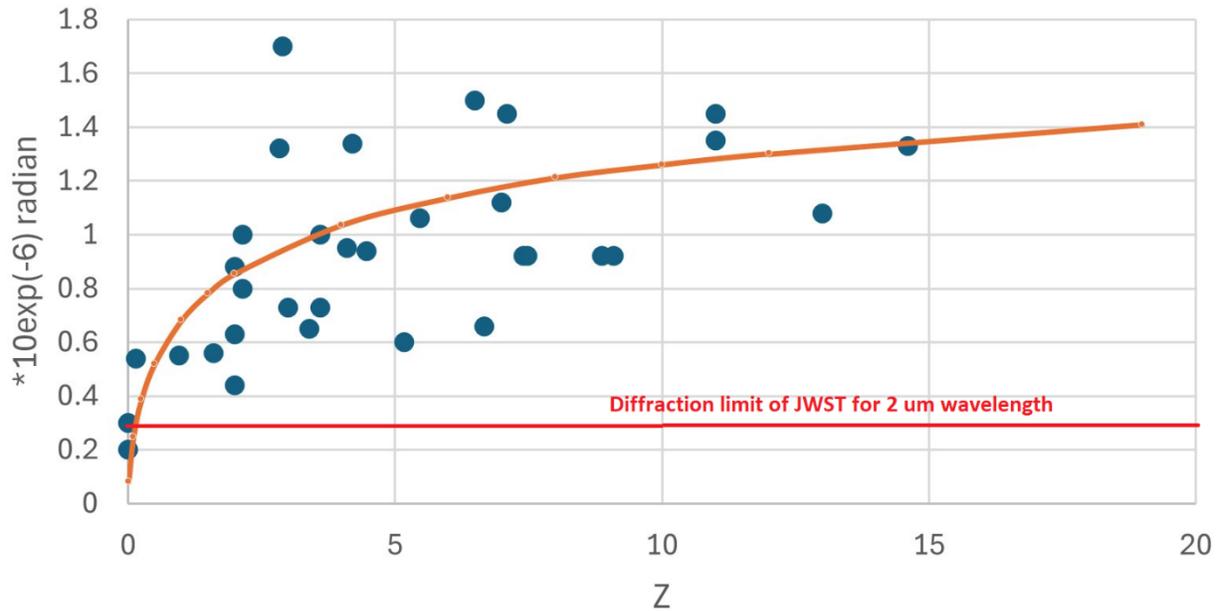


The same problem with little red dots – they all dots, not ovals, despite from any reasonable theory the well developed galaxy with big black hole in the middle (explanation of little red dots) must have ellipsoidal shape and being more frequently visible as oval, not circle. Actually as it turned out not all little red dots have active galactic nucleus inside, some of them have not but they looks exactly the same by telescope JWST [51,52]. Careful measurement of spectra for all of them demonstrated a strange thing – some of them have broadened H_α lines (indication of accretion by huge black hole) but some of them not – the line width is close to what is expected without any black hole [51,52]. Even GPT from Google emphasizes that nature of little red dots is unknown and more research is necessary, yet they all looks the same – circles. This is huge indication that those are different objects (some with active galactic nuclei, some are not) they merely looks exactly the same – all the difference in visual information is completely lost. This is only possible if the light is blurred and resolution is not enough (yet from point of view of distances as calculated by Big Bang cosmology

this is impossible – they all at the same distance as easily resolved objects). The only way this may be explained is that the visual size of those little red dots and galaxies are not about their real size but about the degree light is scattered as a function of Z. This is shown in the final picture of light scattering as a function of Z taken from all the sources – supernovae, little red dots, far galaxies [32]

Orange color curve is the equation $\text{Angle} = \sqrt{\alpha \cdot \ln(1+z)} / \sqrt{3}$ (1) with $\alpha = 2 \cdot 10 \exp(-12)$

Angular size of point-like objects



Despite big scattering it is visible that the angular size of the smallest objects is increasing as expected (from being exactly as it should be for brown dwarfs at Z=0 – diffraction limit of telescope) to much higher values for high Z. Little red dots are in the middle of plot, supernovae on the left and few points on the right are from angular sizes of record breaking galaxies (they are so far away that only the circle of the limited by the light scattering size is visible from Lagrange point near Earth).

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Chapter 3. Old (before Einstein and Big Bang) rejections of eternal universe explained.

As it was already mentioned, well before Big Bang idea the idea of infinite and eternal Universe has numerous problems. One of them was Olbers paradox – if the Universe is infinite, why the sky at night is dark? Due to infinite size the stars should occupy all the space in the sky and it must be bright all the time, day and night. The resolution of this paradox for the tired light hypothesis is unusual and paradoxical too – it is correct! But because the light is slowly losing energy (reddening) we see this light from stars way away from us as microwave background. Indeed, it is very isotropic and arrives from all directions more or less uniformly, so the Olbers paradox is correct – we observe such light. Why however, the light is described by the perfect Planck distribution and how to see the light from enormously far stars and galaxies – here quantum mechanics must help. First it is necessary to remember that light is composed from photons which are bosons. So the correct distribution must be Bose-Einstein distribution (if light is allowed to interact somehow, scatter and lose energy and obtain energy up to final thermodynamical equilibrium). Here is the direct citation from Wikipedia: “Planck’s law arises as a limit of the Bose-Einstein distribution, the energy distribution describing non-interactive bosons in thermodynamic equilibrium. In the case of massless bosons such as Photons and gluons, the chemical potential is zero and the Bose–Einstein distribution reduces to the Planck distribution.” [1].

It means that because the total number of photons is not conserved – they are allowed to be absorbed and re-emitted and not only being scattered with small energy loss like in tired light hypothesis they must arrive to some equilibrium temperature even without being remnants of “Big Bang” (modern treatment of microwave background). Why they have the equilibrium temperature of 2.725 K is a big question – they are not cooled further, they on the opposite start to obtain energy from some type of particles in the space. It is interesting to note, that this temperature corresponds to $Z \sim 1000$ in the sense of red shift and for the tired light hypothesis corresponds to the distance of around 0.5-1 trillion of light years [2]. This is the largest possible distance ever achievable with any telescope – even if the future somebody will build microwave space telescope with enormous mirror, placed away from Solar system to prevent interference at so low temperatures (this is why JWST is at Lagrange point), the light from galaxies beyond this distance of 0.5-1 trillion of light years will be completely thermalized and have no information about the original properties.

Further supports this idea the very famous Bogolubov theorem for the non-ideal Bose-gas with weak interactions [3]. It states that if only weak interactions are present, the energy spectrum should not change from Bose-Einstein distribution (Planck’s for the case of zero chemical potential). Since the presumed interactions which scatter photons are enormously weak this theorem means that they are not influencing distribution for photons – it must stay indistinguishable from Planck’s distribution what is observed.

The observed angular variations of the microwave response in this interpretation are not really indications of the fluctuations during “Big Bang” but more similar to caustics easily observed when light is propagating in non-uniform media. In this case big galaxy clusters (visible and not visible yet) are bending otherwise completely isotropic light from 1 trillion of light away galaxies into the bizarre shape in the vicinity of Earth. It is possible even to develop algorithms similar to image reconstruction from optical caustics [4] to the microwave background.

Second “old” paradox from before Einstein and Big Bang is heat death paradox [5]. In short – the stars do not have fuel enough to shine indefinitely, according to modern physics ideas they must be eventually converted into neutron stars and black holes unless the gravity will start to compress

Universe again into the initial hot spot after which the second “Big Bang” follows etc (oscillating universe [6]). In this explanation the eternity is actually preserved but on global level – the energy is conserved it merely goes from matter to light and high energy particles (present stage of cycle), then back into matter during the “Big Crunch” through unknown yet mechanisms. However, there is already a possibility to explain static universe using known physics from 20th century, which makes the non-expanding Universe effectively infinite and eternal (in physical, not mathematical sense meaning that humans has no way to evaluate the real size or age of real Universe – we merely not yet discovered necessary laws of physics). This idea is expressed in [7].

From historical perspective the whole cosmology was created during the first quarter of 20th century, when it was already clear that stars are using nuclear fusion to generate energy. Creation of H-bomb confirmed this idea in Earth conditions – stars are slowly burning hydrogen into helium, then helium into carbon, then further and up to iron, then they either supernova or nova and that is all – all matter is converted to heavier elements and light. Unfortunately the idea of conversion of energy to matter arrived much later – in the middle of 20th century Soviet academician Goldanski predicted two-proton decay of the excited nuclei [8], which process was discovered later (at the end of 20th century) and thoroughly investigated in the 21st century. There is no really new physics here, this is a spallation process, when the overexcited nucleus partially evaporates back into protons, alpha-particles and lower in mass nuclei, capable of fusion again, effectively converting energy into matter with conservation of hadron number (no quarks or antimatter is involved). At present day even three-proton decays are known and investigated [9,10]. It is well known fact that in the upper layer of Earth atmosphere the excess of neutrons is exactly due to process of spallation [11] – high energy particles from Solar wind effectively smashes nuclei into neutrons, alpha-particles and lower in mass nuclei, converting energy of such solar wind into matter (effectively the process opposite to nuclear fusion).

This idea is easy to understand from chemical perspective – if you have the processes which are converted matter into energy and energy into matter, eventually the equilibrium will be reached at certain temperature – because the more you convert matter into energy, the higher the corresponding temperature and easier to break apart what was produced by the chemical reaction. For fully isolated system the equilibrium will be reached inevitably – no need for constant expansion of the reactor vessel which is effectively cooling the reaction mixture (chemical analog of Big Bang). The temperature in physics is of course by far more complex issue compare to chemistry, but the direct observations of cosmic rays by satellites confirmed the presence of particles with huge energies (up to 2 GeV protons) which easily break many nuclei they met into smaller particles converting energy of those cosmic rays into matter. The important open question is how they got this enormous energy (so the real temperature of Universe is somewhat difficult to describe – from 2.75 K for photons to billions of Kelvin for such cosmic rays), but they do were observed and do convert energy into matter through spallation (and more simple and less energy demanding two- and three-protons decays) thus creating the second process necessary for thermodynamic equilibrium and preventing stars from losing energy (a particular star will of course burned out but the matter created will be collected into new star and the process repeats again and again). The problem of cosmology is those processes (and presence of high energy cosmic rays) were discovered after Big Bang was established as the main paradigm, so it was too late to implement them into the dynamic and thus the wrong paradigm prevailed.

Undoubtedly the direct application of those mechanisms to the cosmic equilibrium needs re-evaluation of the age of the Universe. They are way too small for the present day paradigm (13

billions of years). Only after understanding that real age of Universe is much larger (trillions of years) all the problems disappear – now galaxies have more than enough time to fully develop, the processes of energy conversion into matter spread along vast space of interstellar distances may be on total strong enough to convert energy to matter and matter to energy, galaxy is an open system, obtaining energy from other galaxies (that creates exchange of matter across the local part of Universe and prevents too much of variety of galaxies – otherwise some galaxies would be developing too fast), and how black holes are converting back into normal matter is an open question (possibly by Hawking radiation). The situation with conversion of energy back to matter looks similar to the discovery of water cycle on Earth – the rain is a big easy to see and feel phenomenon (even animals understand that). But evaporation water back is a slow and invisible by naked eye event (due to transparency of the water vapor). No doubts the idea of some kind of god adding water to the sky preceded the idea of water cycle which really was only developed by ancient Greeks [12]. It may be exactly the same situation here – there is no accurate accounting of the effect of conversion of energy to matter is done so far.

With those issues possibly resolved by simpler explanation, how the Universe would be originated in New Physics cosmology? The sad answer is that the origin would be completely unknown for now. Actually New Physics in my approach always goes from local approach – any unexplained phenomenon must have local explanation (this is a major difference from Big Bang cosmology, which prefers global explanations). Red shift of light is local phenomenon (something wrong with our understanding of light locally, the light is losing energy locally – all the time it travels or some local strain of space is responsible – see the Introduction). In Big Bang cosmology this is global phenomenon – the whole Universe is expanding that is why the red shift is present due to Doppler-like effect. Dark matter in New Physics is a local phenomenon – either undiscovered yet ultralight matter interacting with light readily (see below) or the distortion of the gravity by some local unknown yet force. In Big Bang cosmology it is a global phenomenon – during the Big Bang the dark matter was unevenly distributed among galaxies, that is why one has a lot and another nothing, not because of the local properties of those galaxies but because of global effect. In New Physics dark energy is merely an error in interpretation due to light scattering, in Big Bang cosmology it is a global something synchronously developing through the history of the whole Universe (modern interpretation of evolution of dark energy after DESI). After explaining those local phenomena other phenomena will be discovered, also explained locally and it is possible that the origin, size, age of Universe as a whole will be completely unknown even in the far future. The big problem of matter-antimatter non-equilibrium may also have a local explanation – if the Universe is so large and so old, even slightest difference in behavior of matter versus antimatter will not allow accumulation of antimatter in space (because antimatter is actually born in some processes in galaxies). It means that this slightest difference creates its own local equilibrium which dictates that total amount of antimatter present is negligible with respect to total matter present locally (but not zero, this ratio is merely very small, similar to the presence of CO₂ vapor over solid diamond at room temperature – some atoms must evaporate and instantly oxidize to carbon dioxide due to oxygen presence in the air). In essence the whole approach of New Physics throws our understanding of Universe back for a century and a half toward infinite and eternal something of completely unknown origin.

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Chapter 4. Dark matter possible candidates.

Dark matter is one of the phenomenon which should be explained relatively easily if the correct ideas are taken into consideration. First it is necessary to understand that usually a dramatic shift in theoretical understanding of something comes only after some small and seemingly unimportant experiment which is deemed critical [1]. There are several experimental observations and one critical contradiction for the dark matter. First there are galaxies without dark matter – the rotation curve is exactly as it should be from point of view of visible mass distribution. Especially important that such galaxies are ultra-diffused ones [2] – no much light is generated, they are hardly observed. Second the famous Tully-Fisher relation connects in direct sense the brightness of the galaxy and rotation speed [3], it is only presumed that brighter galaxy has larger mass, so this relation is converted to mass-rotation speed relation – in direct measurement it is about light, not mass. And third the most important is the so-called cusp problem [4] – why direct calculations of the dark matter always show the absence of it in the center of galaxy (or only little presence) while all the theories about it claim that dark matter is only gravitationally interacting with matter, it must be abundant in the place with the highest gravity and highest pull (gradient of gravity) – in the center of the galaxy. Recent super-accurate measurements on the closest to Milky Way galaxy – Andromeda galaxy just confirmed this problem again [5]. As it is mentioned in [1] usually the small hint from experiment may stir the attention of theoreticians toward the right direction and the solution will be found quickly. In this situation this hint is light itself. All three facts directly connected not to mass but to the light itself. From cusp problem it follows that light is virtually pushing away dark matter (may be not virtually, may be directly?) because the center of galaxy is also most illuminated part of the galaxy. First and second facts also about light – no light means no dark matter and more light means more rotational speed (more the discrepancy between what is expected and what is observed thus more dark matter after all). The reasonable shift in reasoning is the direct involvement of photons into dark matter (not dark after all, merely not visible by ordinary means, but somehow connected with light).

Those particles which are responsible for the light scattering for the tired light hypothesis are actually excellent candidates for this light matter (“dark matter”) particles [6]. First it is necessary to evaluate the properties of them. From the equation $\Delta E = -\alpha \cdot E$, the discrete steps of ΔE for photons energy loss, for the photon of green light of 2 eV energy and for $\alpha = 2 \cdot 10 \exp(-12)$ the energy loss would be starting from around 4 pico-eV. During the travel photons are losing energy and with spectra present they already known to hold this linear relation till around 28.5 micron (lower energy level for JWST is 28.5 μm) with energy of 0.0435 eV, so the change of energy would be $\sim 8 \cdot 10 \exp(-14)$ eV (80 femto-eV). The only way the particle is capable of removing very small energy junks only (and not bigger ones) is that the particle itself is very small in total energy (mass). Any particle with total energy larger than those pico- to femto-eV range necessarily will have the encounters which would remove much larger energy from photons and make the ratio $\Delta E = -\alpha \cdot E$ impossible (and this is experimentally observed fact for 3 orders of magnitude of spectra shift, the spectra shift has a dispersion exactly corresponding to Doppler shift – the strongest experimental observation in favor of Big Bang). Therefore the first deduction would be that the particles responsible for the light scattering are very small in total energy: femto- to pico-eV. Application of quantum mechanics general ideas will allow to evaluate the properties of such "dark matter" (better be called almost completely transparent matter, because it is after all interacting with light). For total energy of $10 \exp(-12)$ eV the energy

expressed in Joules would be $1.6 \cdot 10^{\exp(-31)}$ Joule, for total energy of $10^{\exp(-15)}$ eV the energy expressed in Joules would be $1.6 \cdot 10^{\exp(-34)}$ Joules. The effective mass may be estimated using the relation $E=m \cdot c^2$ (the relativistic mass, because such particles are moving with speed very close to c). For pico-eV particle it is $1.78 \cdot 10^{\exp(-48)}$ kg, for femto-eV particle it is $1.78 \cdot 10^{\exp(-51)}$ kg. The pulse may be calculated using $E=p \cdot c$ relation: for pico-eV particle the pulse is $5.33 \cdot 10^{\exp(-40)}$ kg*m/s and for femto-eV particle the pulse is $5.33 \cdot 10^{\exp(-43)}$ kg*m/s. Since pulse is known the important characteristic of the particle - de-Broglie wavelength may be easily found using $\lambda=h/p$ here h is Planck constant. For pico-eV particle de-Broglie wavelength is $1.24 \cdot 10^{\exp(6)}$ meters and for femto-eV particle it is $1.24 \cdot 10^{\exp(9)}$ meters (1/3 of Earth to Moon distance).

For such enormously large de-Broglie wavelength no doubt the light is not interacting with the particle easily, the relative cross-section of the interaction (dimensionless probability) may be evaluated as the square of diameters of "particles" sizes. For photon it would be wavelength (500 nm for green photon) and for particle which scatters light it is de-Broglie wavelength. Then the dimensionless cross-section for pico-eV particle would be $\sigma=[500 \cdot 10^{\exp(-9)}/1.24 \cdot 10^{\exp(6)}]^2=1.6 \cdot 10^{\exp(-35)}$ and for femto-eV particle it would be $1.6 \cdot 10^{\exp(-41)}$.

How frequently the photon is scattered on the route from supernova to the Earth to have the scattering parameter of $2 \cdot 10^{\exp(-12)}$? From the formulas outlined in Chapter 2 and assuming for $z=1$ supernova the distance between the star and Earth of 11 billions of light years ($1 \cdot 10^{\exp(26)}$ meter) we may have: after N scattering

$$E_N/E_0=1/(1+z)=(1-\alpha)^N \quad \ln(1/(1+z))=\ln(0.5)=N \cdot \ln(1-\alpha) \sim -N \cdot \alpha$$

and $N=3.47 \cdot 10^{\exp(11)}$ for the distance traveled of $1 \cdot 10^{\exp(26)}$ meters. Therefore the average distance traveled between the interactions is $L=2.9 \cdot 10^{\exp(14)}$ meter (approximately 268 light-hours or 11.2 light-days). In order to evaluate the mass density of such "light matter" the assumption is as follows: during the travel of 11.2 days the effective volume of the photon has covered is $V=(\pi \cdot \lambda^2/4) \cdot L$, here λ is the wavelength of the light and L is traveled distance before one encounter. $V=1/4 \cdot \pi \cdot (500 \text{ nm})^2 \cdot 2.9 \cdot 10^{\exp(14)}=57$ cubic meters. During traveling through this volume photon interacts only once, but because the probability of interaction is very low the total number of those "light matter particles" is very large and mass density is $\rho=m/(\sigma \cdot V)=1.78 \cdot 10^{\exp(-48)} \text{ kg}/[1.6 \cdot 10^{\exp(-35)} \cdot 57 \text{ m}^3]=1.95 \cdot 10^{\exp(-15)}$ kg/cubic meter for pico-eV particles and $1.95 \cdot 10^{\exp(-12)}$ kg/cubic meter for femto-eV particles. This value is comparable to the interstellar visible matter (mainly protons) of $1.67 \cdot 10^{\exp(-15)}$ kg/cubic meter [7], less than the total mass density of Milky Way ($2 \cdot 10^{\exp(-10)}$ kg/cubic meter [8]) and larger than the calculated mass density of dark matter in the halo around Milky Way (0.2-0.4 GeV per cubic cm [9]) which would be $3.55-7.1 \cdot 10^{\exp(-22)}$ kg/cubic meter. The values obtained are reasonable and interestingly, the light matter ("dark matter") interacting with light will be looking close to what astronomers are expecting - it must form halo. Because the particles are interacting with photons and are so light, they are virtually pushed away by any photons (even microwave ones) from the stars, away from galaxy (full of photons) but due to some gravitational interaction they can not really lost the galaxy completely. They are indeed forming the halo around galaxy (and even more so pronounced halo around galaxy clusters) - exactly as it is expected from gravitational lensing of light and too fast galaxy rotation. The estimated value of the mass density of those particles from light scattering is also reasonable - not really small and not enormously large (the distribution of them in halo is a separate and very difficult problem). However, the enormously small effective mass of them (energy of pico to femto eV) deemed the possibility of

detection of them on Earth virtually impossible - they are swept out of Solar system by photons. Unless they are generated in the Sun itself (and in this case the stream of them directly from Sun similar to neutrinos stream is expected) they are only be possible to research using the light scattering from far stars, supernovas and galaxies.

From perspective of present day physics the search for the so-called axions is what is expected to lead to New Physics – they are indeed ultra-light (contrary to WIMPs which are impossible) and do interact with magnetic field (so possibly with light). Those axions may be after all be exactly what is necessary – light scattering and easily interacting with light, being pushed away from center of galaxy (solution of cusp problem) and form a halo around galaxy.

Other candidates for the dark matter were already described in previous publications: gravitational constant slightly increases due to polarization of quantum vacuum [10,11], space-time itself is polarized by gravity beyond Einstein [12], gravitational dipole is not zero and quantized (quanta is h/c for ultra-relativistic particles like photons and since photons are everywhere, this creates added gravitational force) [13, 14]. Some of the ideas are obviously contradict to each other – but this is the part of the overall approach. It is called Experimentalist Approach and the overall task is not to create the perfect theories of New Physics (beyond Big Bang cosmology and Standard Model in elementary particles) but to outline the directions where the experiment may finally break the existing paradigm clearly and inexplicably. In this situation the overall direction of theoreticians will be diverted in the right direction and they will create New Theoretical Physics much faster.

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Chapter 5. Conclusions. Where does the present book stand with respect to mainstream modern physics?

After the launch of James Webb Space Telescope the avalanche of the new ideas appeared for the cosmology. Still prevailing today is Big Bang cosmology – with sudden event of Universe birth, quick initial expansion and long slower expansion dominated by the evolution of the dark energy. While the main idea of this book is actually an alternative to expanding universe paradigm in some particular details it agrees with mainstream ideas about where to perform important experiments. Everybody understands enormous importance of supernovae observations at high Z (JADES transients survey), which must generate better distance ladder (from mainstream cosmology it is solution of Hubble tension). Such experiments will deliver the absolutely essential observations of time dilation for supernovae curves – the predicted by Big Bang cosmology light curve dilation of $1+z$ is so big that it would be impossible to miss if it is present compare to much smaller dilation for tired light cosmology. While from my perspective search for dark matter being WIMPs is useless, the search of ultra-light particles called axions is well justified – they may be responsible for light scattering. Not only because of tired light mechanism, the search for such particles is an important shift in paradigm of fundamental experimental physics – all 20th century was dominated by the search in the direction of higher energies, now it is time to search for the lower energy particles – well below photons and even neutrinos. It may lead to numerous discoveries like possible 5th force “in the gap” – between gravitation and electromagnetism and many others not necessarily related to cosmology and cosmological red shift of light. That direction is exactly the direction I am personally pushing on my blogspot Tipikin . Through the ideas of gravitational dipole and gravity influencing the other forces through quantum vacuum I am also trying to devise experiment to pave the way for quantum gravity (unification of two incomplete theories, General Relativity and Quantum Mechanics) – here I completely agree with mainstream that this is the correct direction of research (problem is enormously complex, however). And in all my ideas I am always looking only for the effects which are enormously small compare to known relativistic and quantum mechanical perturbations – by no means New Physics may reveal itself on the “household” level in the macroscopic everyday life. I completely agree with mainstream critique of numerous approaches which may explain some particular phenomenon which has difficulty for modern established theories but in parallel creates tens of predictions which would be easily observed already for hundreds of years. Any predicted experiment must generate so small difference for already existing phenomena that it would be only a small perturbation well below error level and only revealed in special conditions. Essentially the search for such special conditions and how implement them in the most economical way is the purpose of all my books.

The disagreement with mainstream physics is not in devising new experimental ideas (it is made every day by hundreds of physicists) but in the understanding of level of change to be performed. By no means mainstream physics is ready to sacrifice Big Bang, expansion of Universe, dark energy ideas – all the new mainstream propositions would be to implement more “epicycles” to keep them in place. From my perspective nothing like those ideas are sacred and even energy conservation law is under scrutiny. However, if the idea of experiment generates the outcome which would be observed during Newton time it will be thrown away instantly – only something extremely small may stay.